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Antenatal Paediatrics*

BY

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THE decision to elect into the Fellowship of this College representatives of those branches of medicine intimately connected with the practice of obstetrics and gynaecology showed wisdom and vision. You could have chosen a paediatrician who deserved the honour more than I do, but none who appreciated it more highly, and I cannot adequately thank you for the further honour of this lectureship.

So far as midwifery is concerned, I am almost a Victorian, being in fact a neo-Edwardian. In my student days we were supposed to attend 20 labours in the district, but often this number could not be encompassed in the 2 or 3 weeks allotted to us for the purpose. We were initiated into the mystery of the art by the student or students who preceded us and who attended the first 2 or 3 labours with us and then left us to our own devices. My immediate predecessor is now my distinguished senior ophthalmological colleague. He took me to my first case, but we soon got into difficulties and I was dispatched to hospital to fetch the obstetric House Surgeon, now another of my colleagues and Dean of the Dental Hospital, but his great knowledge of dentistry and obstetrics was little help to the patient or to us. Hence, once more, I was sent off; this time to the home of the Honorary Obstetrician. The house was in darkness and its owner in bed; when, in answer to my ring, he opened the front door, I recognized the picture delineated on some of the cards of the Victorian domestic card game "Snap." This picture had the title "Who would be a doctor?" and showed a lugubrious-looking individual, clad in a nightshirt, and holding a candlestick with a spluttering candle in it. He received me kindly and accompanied me to the house, and after an examination decided that he would have to do craniotomy. All arrangements having been made, including the traditional bucket of water for the reception of the foetus so as to make quite sure that it did not survive, the operation proceeded and I saw my first birth and obtained my first experience of neonatal death. Needless to say, that experience put the fear of midwifery into me; a fear which has never been conquered, and which was one reason why for many years I lost interest in the subject. Actually it is only since I have been engaged in the study of neonatal

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disease and death that I have realized how greatly I have been handicapped by my ignorance of midwifery.

Paediatricians have fully recognized the important effects of labour upon the new-born baby, but have been somewhat slow in realizing the great influence, for good or for ill, of antenatal conditions on the foetus, and, although they are concerned with the production of healthy children, they have shown strangely little concern about the state and efficiency of the factories in which these products are made.

> " In the dark womb where I began
> My mother's life made me a man;
> Through all the months of human birth
> Her beauty fed my common earth;
> I cannot see, nor breathe, nor stir
> But through the death of some of her." [1]

The paediatrician of the future must be concerned with the wellbeing of the child from the moment of its conception and sometimes even before that event, since, to quote Sir Thomas Browne,[2] " we live, move, have a being, and are subject to the actions of the elements, and the malice of diseases, in that other World, the truest Microcosm, the Womb of our Mother." It is this aspect of paediatrics—antenatal paediatrics —which I would stress to-day, and my remarks should perhaps be addressed even more to paediatricians and general practitioners than to obstetricians.

Since this part of my lecture was written on Election Day, it was perhaps natural that I should reflect on the national importance of my subject. Actually, this has been recognized by no less a person than Mr. Winston Churchill who, in one of a series of election broadcasts, said: " We are determined to secure the nation's future by seeing that from birth, and even from before birth, every British infant is well nourished and given a chance to grow up sturdy and strong." In other words, both paediatrics and antenatal paediatrics are matters of present-day politics. Whether their chance of real success has been enhanced thereby, I leave to your judgment, but it does show that these subjects have become practical possibilities, because a political leader is not likely to endorse sentiments which are known to be unpopular with the electors. What I believe will turn out to be the most solid contribution so far made to antenatal paediatrics is the appointment by this College of a committee " To correlate and if necessary gain information with regard to the effect of the level of nutrition of pregnant mothers on their own health and that of their offspring." When this committee has completed its work and when the report on neonatal disease and death, now being prepared by this College and the British Paediatric Association, is produced it will be found that the structure of antenatal paediatrics has been well and truly founded upon a rock and that it will not fall when the rains, floods and winds of adverse criticism beat upon it.

The weight of the new-born child bears an important relation to its viability and to its anatomical and physiological development or " vigour," to use Bourne's term. Unfortunately there are no specific criteria of vigour and, therefore, in the absence of oedema, the weight of the new-born baby has to be taken as the index of its state of nutrition. Hammond[3] has suggested that the nutrients in the maternal blood-stream are distributed between the foetal and maternal tissues in the same way as between the different maternal tissues, namely, according to the metabolic rate of the tissue concerned; those possessing high rates taking a greater share than those possessing low rates. At the beginning of pregnancy the foetus has a high metabolic rate, but as it grows this probably diminishes and the competition between foetal and certain other maternal tissues becomes more severe.

There are also other factors to be taken into account, such as the competition for nutrients between the placenta and the foetus and the fact that the different tissues of the foetus compete with one another exactly as the maternal tissues do.

Although it is reasonable to suppose that some abnormal influences act on the foetus throughout the whole of the pregnancy, the results produced in the first 3 and the last 3 months are probably more important than those in the middle period. The effects on the foetus differ in these 2 periods; those of the first 3 months being chiefly concerned with malformation and of the last 3 months with foetal immaturity and disease.

Diabetes furnishes an example of a maternal condition which presumably acts throughout the whole of foetal life, and which produces serious results, since foetal or neonatal death occurs in about 30 per cent of such pregnancies even when the disease is controlled by insulin. Many reasons have been suggested to account for this mortality; inadequate treatment; the presence of maternal complications such as toxaemia; hyperprolanaemia; hydramnios; a large foetus; increased incidence of congenital abnormalities; infantile hypoglycaemia; but there is no general agreement that any of these are causal factors. A recent investigation by Miller, Hurwitz and Kuder,[4] produced the following remarkable results: Foetal and neonatal mortality was 5 times greater, and babies weighing over 11 pounds 80 times more frequent among the children of diabetic than among those of non-diabetic mothers. Furthermore, these trends were noticeable before the mothers developed diabetes, and the mortality actually reached this high level 5 years before the onset of the disease. When the diabetes was so mild that the mother did not require insulin or even when she only had glycosuria during the last 3 months of pregnancy and had an otherwise normal carbohydrate metabolism, the increase in mortality was 4-fold. This increase was not due to the size of the child, since the rate was the same for babies between $5\frac{1}{2}$ to 10 pounds as for those over 10 pounds. Autopsies on the new-born children of these mothers showed hyperplasia of the islands of Langerhans; increased erythropoiesis in the liver and cardiac hypertrophy which, in children who survived, disappeared in 6 weeks. These changes also were found in children born before their mothers had signs or symptoms of diabetes.

The Period of Malformation.

The 5th to the 9th week of pregnancy is the critical period in the development of the lens, teeth, palate and septa of the heart, and some of the malformations of these organs were attributed by Shakespeare to "the foul fiend Flibbertigibbet" who "gives the web and pin, squints the eye and makes the hare-lip."

1. *Malnutrition and Malformations.*

There is, however, increasing experimental evidence that congenital deformities of these organs may be due to malnutrition; for instance, Hale[5] found that the pigs born to sows who were fed on a diet deficient in vitamin A had congenital defects of the eyes, and Warkany[6] has recently reported similar findings in rats. Previously, by restricting other articles in the diet of pregnant rats Warkany and his colleagues[7] had shown that the young rats were born with deformities such as shortening of the mandible; cleft palate; shortening and distortion of the limbs; syndactyly; fusion of the ribs. Clearly it is difficult to prove that this state of affairs occurs in the human foetus; indeed, the relation between malformations and nutrition is an example of the

pitfalls which beset attempts to draw correct deductions about foetal health. Many doctors maintain that there has been an increase in malformations during the war years, yet it is generally accepted that during this time pregnant women have been more adequately nourished than previously with the result that, again to quote Mr. Churchill, "the death-rate of mothers and of babies has fallen to the lowest figure we have ever known in this country; so has the rate of stillbirth." The fall of the stillbirth-rate from 36 per 1,000 live births in 1940 to 28 in 1943 has indeed been described as one of the major victories of the war. A reduction in neonatal mortality necessarily causes a relative increase in the number of deaths from congenital abnormalities because so many of these are incompatible with sustained life, but in complete disagreement with the views expressed by so many doctors, the returns of the Registrar-General show that, apart from an increase in deaths from hydrocephalus in male infants in the years 1940 and 1941, there was no absolute increase in the deaths from malformations between 1936 and 1943.

2. *Infection.*

From time to time the possibility that an infection may cause congenital defects has been discussed, and recently the association of German measles in the mother with defects in the foetus has been stressed. The possible connexion between these two conditions was first pointed out by Gregg,[8] an Australian ophthalmic surgeon, who, in the first half of the year 1941, noticed an unusual number—in fact a mild epidemic—of congenital cataracts among babies; furthermore, the appearance of these cataracts did not "exactly correspond to any of the large number of morphological types of congenital and developmental lenticular opacities that have been described." On enquiry he found that with few exceptions their mothers had suffered in the early months of pregnancy from an exanthem simulating a severe form of German measles; adenopathy was marked, swelling of the ankle and wrist joints occurred and the degree of constitutional disturbance was greater than in any epidemic of this disease in his experience. Between December 1939 and January 1941 he collected 78 cases of congenital cataract, 44 of which also had congenital heart disease. Moreover, many of the babies were small, ill-nourished and difficult to feed. Impressed by these findings, Swan,[9] of Adelaide, and his colleagues sent out a questionnaire to all medical practitioners in South Australia asking them to report on all babies born to mothers who had suffered from acute exanthemata during pregnancy. As a result they examined 61 infants, of whom 36 showed congenital defects such as cataract, deaf-mutism, heart disease, microcephaly, mental retardation and quite a few multiple defects. Forty-six of these 61 mothers developed rubella during the first 3 months of pregnancy and 30 of their children showed congenital defects; 1 had rubella and measles and the child bilateral cataract; 1 had either rubella or measles and another rubella and mumps, both children being normal; 7 had measles and all the children were normal; 1 had mumps and the baby bilateral corneal opacities. The mothers of 3 children with congenital defects denied the existence of any disease during pregnancy and the mother of 1 child who had cataract and heart disease had an illness during pregnancy diagnosed as "influenza." On the basis of this evidence these workers drew the somewhat amazing conclusion that "when a woman contracts rubella within the first two months of pregnancy, it would appear that the chances of her giving birth to a congenitally defective child are in the region of 100 per cent and if she contracts it in the 3rd month about 50 per cent." In

a later communication[10] they reported 10 more instances of congenital defects in association with maternal rubella and Evans,[11] working on the same material, found that 23 of 34 babies whose mothers suffered from German measles during pregnancy had congenital dental defects which were most severe in those babies whose mothers contracted the disease in the 6th to 9th week of pregnancy; the critical period for dental development. In America 14 cases of congenital defects associated with maternal rubella have been reported (Reese,[12] Erickson[13]). Many paediatricians in this country have seen isolated examples, but the largest number has been reported by Martin,[14] who, by means of a questionnaire, found that the mothers of 24 out of 85 deaf children born in 1940 to 1941 had rubella during the first 4 months of pregnancy and 6 others probably suffered from it. Some of the children also had defects of the eye, and 3 had defects of both the eye and the heart. Of the remaining 55 cases, the deafness was hereditary in 7 and in 13 was caused by meningitis.

These rather arresting observations suggest three questions:

First: Is the relation between maternal rubella and congenital defect statistically significant? The Australian statistics have been criticized because in some of them only children with positive defects were reported and there is no information as to how many women who had rubella during pregnancy gave birth to normal babies. According to the *Lancet*[15] these studies do not meet statistical requirements and "all babies born of the defined mothers should be observed together, preferably with some comparable group of babies, born of mothers whose pregnancies were not accompanied by any of the diseases in question." It seems to me that the most important points which suggest that the association is a causal and not a chance one are the facts that (*a*) the German measles occurred during the first 3 months of pregnancy—that is during the critical months in the development of the organs affected—and (*b*) that although 8 mothers had other infectious diseases during pregnancy, only 1 instance of congenital deformity occurred among their babies.

Secondly: Since rubella is usually such a mild disease that it may easily be overlooked or wrongly diagnosed, was the maternal illness in fact due to rubella? Gregg thought that the 1940 epidemic was the most severe he had ever seen and wondered if it could be any other exanthem, but came to the conclusion that it was German measles, and there was said to be no other disease epidemic at the time with which the South Australian cases could be confused. The severity of the disease was attributed to an increase in the virulence of the virus due to wartime conditions, particularly to overcrowding in camps. In my opinion, it should be accepted that the disease was rubella, a decision which naturally raises a 3rd question: Why should a disease normally so trivial in the adult and child produce such devastating changes in the foetus? The answer suggested is that in mammals the embryonic cells are more susceptible to virus infections than adult tissues; more severe changes, therefore, should be seen in the foetus and these should be especially marked at the period of greatest embryonic activity, i.e. the early weeks of pregnancy.

The causal relations between rubella in the mother and congenital defects has not been proved and further investigations should be carried out, but the evidence produced is sufficiently convincing to make it unwise for expectant mothers—especially in the early months of pregnancy—to be exposed to the risk of infection with German measles and perhaps with other exanthemata also, although it is insufficient to

justify the termination of pregnancy. On this subject Vertue[16] has made the interesting comment that "Science has done nothing about Flibbertigibbet unless you count the suggestion that one of his other names is German measles."

Period of Foetal Immaturity and Disease.

This can be discussed under 3 heads, (1) nutrition and nutritional disorders, (2) immunity, (3) disease.

1. *Nutrition and Nutritional Disorders.*

The normal full-time baby starts life with a satisfactory equipment of vitamins, hormones, metals, etc., but after birth there follows a negative phase in which the store of vitamins diminishes and haemolysis and hypoprothrombinaemia etc., occur. This phase is short where vitamin A and vitamin K are concerned; longer for vitamin D, calcium and phosphorus; longer still for vitamin C, iron and thyroxin; and lasts until the baby is able to obtain these factors from its diet or manufacture them for itself. If storage during pregnancy has been defective owing to premature birth or to inadequate nutrition of or to disease in the mother the diet of the baby may not be able to bring the levels up to normal and morbid conditions, such as haemorrhagic disease of the new-born, nutritional anaemia, tetany, rickets, scurvy develop; diseases which are even more likely to occur if the baby's diet is also defective. Although hypoprothrombinaemia is more marked and lasts longer and therefore the liability to haemorrhagic disease is greater in the premature than in the full-time child, it is generally accepted that there is little or no storage of vitamin K in the body. In spite of this, administration of the vitamin during the last month of pregnancy is usually recommended by the authorities. Hypoprothrombinaemia occurs in liver diseases and the hypoprothrombinaemia of prematurity is probably due to the defective liver function which occurs in prematurity; nevertheless, the foetus can be adequately protected against haemorrhagic disease if the mother is given 5 to 10 mg. of menaphthone subcutaneously directly she goes into labour.

If the mother during pregnancy shows evidence of a deficiency disease the foetus at birth is also likely to be affected with that disease. For instance, with 1 exception, the only examples of true foetal rickets are the offspring of mothers suffering from osteomalacia (Maxwell[17]). The exception is recorded by Richard Ellis[18]: a baby when born at term showed multiple fractures, beading of the ribs, hypophosphataemia and typical radiological signs of active rickets although its mother was healthy and had normal long bones on radiological examination. Neonatal tetany occurs from time to time and although sometimes it may be due to haemorrhages into the parathyroid, it is usually due to deficiency of blood calcium in the mother. We can accept it as axiomatic that an unusually early onset of rickets, and frequently also of tetany, in the baby is due to deficiency of calcium, phosphorus and vitamin D in the maternal diet during pregnancy.

Maxwell[19] has reported the occurrence of keratomalacia in infants whose mothers' diet was deficient in vitamin A. Women suffering from beri-beri of pregnancy show a shortage of vitamin B_1, and frequently their offspring are stillborn or show evidence of polyneuritis and Huggett[20] states that foetal haemorrhages are said to occur if the mother is lacking in vitamin C.

When the diet of a pregnant animal is deficient the embryo has the prior claim to the nutrients, but iron is sometimes an exception to this rule; thus iron deficiency anaemia in rats can be cured by a diet of

milk and yeast, but their young are born anaemic (Parsons and Hickmans[21]); again, a baby may develop iron deficiency anaemia shortly after birth, although its mother was not anaemic during pregnancy. If a mother has an iron deficiency anaemia during pregnancy her baby may not be anaemic at birth but this is not invariably the case; on the contrary, the baby may show an iron deficiency anaemia at or shortly after birth or develop a severe type of nutritional anaemia of infancy (Parsons[22]).

It seems, therefore, clear that everything should be done to prevent the premature birth of the infant and that the mother's diet should be more than adequate and contain full supplies of vitamins, calcium, phosphorus and iron. The storage of these essentials by the foetus is said to take place chiefly during the last third of pregnancy, during which time, according to Huggett,[20] two-thirds of its calcium phosphate, three-quarters of its protein and four-fifths of its iron are laid down. Although in great part obtained from experimental animals, there is a considerable amount of evidence to support this view. Hugounenq[23] showed that two-thirds of the iron present in the body of the full-time infant was laid down during the last 3 months of pregnancy; an observation which, in not so far as it concerns the deposit of iron in its chief storage depot, the liver, has been confirmed by Ramage, Sheldon and Sheldon[24]; these investigators also showed that the storage in the liver of copper and calcium followed similar lines and that the amounts of all 3 elements reached their peak at birth (see Table I). Moreover, their results suggested that an adequate supply of calcium is necessary to ensure the storage of iron and copper.

Indirect evidence of the importance of storage in the later third of pregnancy is provided by the facts that premature

TABLE I.

	Duration of pregnancy		Age at which full-time value is again reached
	0–24 weeks	Full time	
Total Iron (mg.)	15.2	73.3	5th year
No. of examples	6	6	
Total Copper (mg.)	1.33	7.26	5th year
No. of examples	7	8	

infants develop an iron deficiency anaemia at an earlier age and suffer more frequently from rickets than full-time babies. Again, Ebbs, Tisdall and Scott[25] found that rickets, tetany and anaemia were more frequent in babies under 6 months of age whose mothers were taking a "poor" diet than in those taking a "good" or a "supplemented good" diet. Nevertheless, their results cannot be accepted as evidence in favour of the point under discussion because the "supplemented good" diet was only "supplemented" during the last 3 months of pregnancy and there were no controls who took this diet throughout pregnancy. The same criticism applies to an investigation carried out by my colleague, the late Dr. Gittins, who gave full doses of iron daily to expectant mothers for 1 to 3 months before delivery and found that their infants had a definitely higher haemoglobin at each age period than those born to mothers who were not given the extra iron. At the same time, both these investigations strongly suggest that the chief storage of iron, copper, calcium and phosphorus does take place in the later months of pregnancy.

In an important series of experiments Wallace[26] has recently shown conclusively that the nutrition of ewes during the latter third, but not during the earlier two-thirds, of pregnancy has a marked and important influence on the birth weight and vigour of their lambs and also on milk production. These experiments do not, however, give

any indication of the effect on the offspring of different levels of proteins, metals, vitamins, etc., in the mother's diet.

From our point of view the following is the crucial experiment: when 28 days pregnant a number of ewes was divided into two groups (A) and (B). From the 28th to the 91st day of pregnancy group (A) who were liberally fed gained 33 pounds, but group (B), fed on a restricted diet, lost 11 pounds. On the 91st day of pregnancy a ewe from each group was slaughtered and its foetus weighed and it was found that the weight was the same in each case (1.7 pounds). The rest of the ewes in each group were then divided into two sub-groups (A.1 and A.2 and B.1 and B.2). Group A.1 were kept on the good diet and gained a further 33 pounds during this period and on the 144th day, the end of pregnancy, their lambs averaged 11.3 pounds weight. Group A.2 were changed to the poor ration and by the 144th day of pregnancy had lost 26 pounds and the lambs weighed 6.5 pounds. Group B.1 were given the good in place of the poor ration and gained 56 pounds by the 144th day and the average weight of their lambs was 11 pounds, almost exactly the weight of those in group A.1. Group B.2 remaining on the poor ration lost another 11 pounds, and their lambs averaged only 5.8 pounds. These results clearly indicate that the weight of the foetus depends upon the nutrition of the mother in the last third of pregnancy. Moreover, all the ewes who were well fed during this period developed large udders, while the udders of those which were poorly fed remained small. These results are shown in Table II.

Although the weight of the non-oedematous new-born baby may be regarded as evidence of its state of nutrition, this cannot be accepted for the mother because of the effect of water retention, particularly in toxaemia of pregnancy. Therefore, any attempt to apply Wallace's observations to

TABLE II.

EWES

	(28 days pregnant)				Length of pregnancy
Groups	A.		B.		
Diet	Good		Poor		
Gain + or Loss − Wt. of foetus in pounds	+ 33		− 11		28–90 days
	1.7		1.7		
Groups	A.1	A.2	B.1	B.2	
Diet	Good	Poor	Good	Poor	
Gain + or Loss − Wt. of foetus in pounds	+ 33	− 26	+ 56	− 11	91–144 days
	11.3	6.5	11.0	5.8	
Udders	Good	Poor	Good	Poor	

pregnant women must be confined to those showing a small increment in weight; it is also essential to remember that at birth a baby is in a much less advanced stage of development than a lamb, otherwise a most intriguing situation might develop in which the baby rises from its cot, totters somewhat drunkenly across the room, clambers into its mother's bed and demands a feed of breast milk. At any rate, this might solve the problem of breast feeding because I am sure the baby would not go in search of a cow! It is probable that baby monkeys most closely resemble human babies and it is desirable to repeat on monkeys the investigations carried out on sheep and other animals.

It is universally accepted that the nutritional state of the pregnant woman has an important influence on the birth-weight of her baby, but this only becomes clearly obvious when the diet is severely restricted as in famine conditions. Moreover, a well balanced and more than adequate diet may not be absorbed normally and the mother

and foetus may then suffer from a "conditioned" deficiency and not from disease due to deficiencies in the diet. The ideal diet in pregnancy and the effects of diet on the pregnant woman were fully discussed by Nixon in his Blair-Bell Lecture,[27] but any attempt to assess the effect of the maternal dietary on the infant bristles with difficulties. According to Young[28] reliable data are not available; nevertheless, we must seek an explanation for the decrease during the war years in maternal, neonatal and infant mortality and in stillbirths, and for the diminished incidence of rickets and infantile scurvy. These results are unlikely to be due to better doctoring and nursing if for no other reason than the fact that both doctors and nurses have been few and overworked. There are certain social differences between pre-war years and the present time, thus:

1. There has been an increase in wages, although this does not apply to the wives of men in the Services.

2. Many mothers have been engaged in industry during pregnancy.

3. The present diet for both mothers and children is almost certainly better than before the war. The rationing system has succeeded in giving everyone a balanced and adequate, although sometimes unattractive, diet, and has provided additional rations of milk and of vitamins A, C and D for expectant mothers and children.

The improvement in dietary is the most likely explanation of the fall in mortality- and morbidity-rates; an explanation which receives considerable support from Baird's work in Aberdeen.[29, 30] We cannot, however, be absolutely dogmatic on this point because some disconcerting evidence has recently been produced; thus, although it is estimated that 70 per cent of the mothers of this country attend welfare centres, only a relatively small proportion of these accept the vitamin A and D tablets provided for them if they are pregnant, or the cod-liver oil for their children. An enquiry at certain welfare centres in Birmingham showed that less than 6 per cent of mothers obtained their vitamin concentrates from other sources. Again, A and D tablets were only made available for expectant mothers in 1943; in 1942 cod-liver oil was allowed, but before that date nothing at all, yet the maternal mortality- and stillbirth-rates were considerably less in 1941 than in the preceding 5-year period (1936-1940), although it must be conceded that Baird[30] has shown that in Aberdeen the greatest fall in prematurity rates and in deaths from congenital debility has occurred since 1942. We cannot deny that adequate amounts of vitamins play an important part in the nutrition of expectant mothers and in the health and nutrition of the infant, yet in view of the foregoing observations how is the low incidence of rickets and the reduction of the mortality- and stillbirth-rates to be explained? I cannot give the answer but possibly the most important factors are the extra milk and the improvement in the bread. It is also noteworthy that in the years immediately preceding the war the lowest stillbirth- and neonatal mortality-rates occurred in well-fed countries such as New Zealand and Holland, and that in Great Britain these rates were the highest in the depressed areas. Besides, even admitting the validity of some adverse criticisms, the investigations carried out in South Wales, Oslo, Toronto, London and Aberdeen lend strong support to the view that the diet and nutritional state of the mother during the latter third of pregnancy affect both the health of the new-born child and the incidence of premature and stillbirths.

2. *Immunity.*

The full-time, healthy new-born baby has a degree of passive immunity to certain infectious diseases—in particular

to diphtheria and measles—but none to streptococcal, staphylococcal and pneumococcal infections which are such important factors in neonatal mortality. Whence come the antibodies responsible for this immunity? Not infrequently, in the later months of pregnancy, Rh antibodies are found in the blood of Rh negative mothers pregnant by an Rh positive father, and the titre may rise during the last 3 months of pregnancy. Moreover, in the majority of cases of haemolytic disease of the new-born the disease starts before birth and Rh antibodies may sometimes be demonstrated in the circulating blood of such babies at birth. It is also known that the titre of diphtheria antitoxin is as high in the serum of the baby at birth as in its mother's serum and that the cord blood of babies whose mothers have been immunized with T.A.B. vaccine shows a high titre of agglutinins. In all these instances the antibodies must have reached the foetus through the placenta; indeed, the fact that the placenta contains large quantities of antibodies is made use of in the prevention or attenuation of measles by injection of placental extract. In certain animals antibodies, particularly those associated with calf dysentery and lamb scour, are transferred from mother to offspring in the colostrum. This difference in the mode of transmission is due to the structure of the placenta; in the cow it is thick being composed of several layers, whereas the human placenta is thin, the blood actually bathing the chorionic villi and thus rendering transference easy. Owing to degenerative changes the human placenta in the last 3 months of pregnancy becomes even more permeable and organisms as well as antibodies may pass from the mother to the baby. It is said that the transfer of vitamin A to the young follows the same rules and it is also interesting to note that a high titre of Rh antibodies has been found in the colostrum of mothers whose babies suffer from haemolytic disease, and sometimes these antibodies are also found, but in much lower titre, in breast milk. Although the titre of diphtheria antitoxin in the baby's serum at birth is as high as that of its mother and is not increased by taking colostrum, the transference of some antibodies by the milk seems to be the only possible explanation of the accepted view that breast feeding confers a degree of immunity to the infections of early infancy.

"The evidence is fairly conclusive that an antibody is a molecule of globulin which, during synthesis, has been specifically modified under the influence of antigen." (Cuthbertson.[31]) This globulin is called gamma-globulin, a description which does not refer to its chemical structure but to its movement in an electrical field; in such a field albumins move fastest, and then in order alpha-, beta- and gamma-globulins. As far as I know the amount of gamma-globulin in the sera of premature or full-time babies has not been estimated, but both the globulin and the total protein of the serum of premature infants are lower than those of the full-time new-born child and these, in their turn, are lower than those of older children. (Hickmans,[32] Darrow and Cary,[33] Rapaport *et al.*,[34].) It seems reasonable to regard the smaller amount of globulin as a factor in the greater liability of the premature than the full-time baby to infection; moreover, if the foetus or baby is badly nourished the "competition for available amino-acids" for purposes of growth may limit the amount of gamma-globulin formed and be one other reason for the liability of such infants to contract infection. On the other hand, the amount of gamma-globulin in the blood may not be a complete measure of the infants' immunity since some of the gamma-globulin may be held in reserve in the tissues of the baby. One further interesting point in this question of immunity in the

new-born is that colostrum contains a higher percentage both of protein and globulin than milk, but in spite of this serum globulin shows the negative phase referred to in regard to other essentials received from the mother *in utero*; in fact it falls until the 4th week, when it commences to rise, reaching the adult level at 4 years.

3. *Disease.*

In the later third of pregnancy it is possible for organisms as well as antibodies to pass from the mother to the foetus by the placental route. As a result the foetus may be born with an established disease or develop it shortly after birth as, for instance, haemolytic disease, syphilis, septicaemia and rarely toxoplasmosis, tuberculosis, scarlet fever, small-pox. I shall confine my remarks to haemolytic disease of the new-born and to toxoplasmosis.

HAEMOLYTIC DISEASE OF THE NEW-BORN.

Haldane[35] has stated that haemolytic disease is responsible for more deaths than any other inherited condition, possibly more than all of them put together, and I want to emphasize that it commences *in utero* and may cause irreparable damage to or even the death of the foetus. I would also stress that sepsis neonatorum may simulate icterus gravis even to the occurrence of kernicterus, and that any or all of the characteristic symptoms of haemolytic disease may be absent at birth; a diagnosis then only being possible by serological tests. It is unfortunate that the number of these appears to increase from week to week, and if Fisher's hypothesis of triple allelomorphs is true, 27 kinds of Rh are distinguishable by serological tests, although some of them only occur rarely; furthermore, to add to our burdens, the possibility that anti-P agglutinins may cause haemolytic disease has recently been raised.

The fact that haemolytic disease starts during foetal life is obvious in hydrops foetalis, its rarest, and in icterus gravis, its most frequent manifestation, but is not so obvious in haemolytic anaemia of the new-born. Both kernicterus and cirrhosis of the liver occur after icterus gravis, but neither has been observed after haemolytic anaemia of the new-born; a condition in which there is only slight jaundice. It is also interesting to note that kernicterus is sometimes found postmortem after an attack of what had been regarded as physiological jaundice. We believe that the kernicterus following neonatal sepsis and that arising from icterus gravis are the result of simultaneous damage to the liver and brain, being, in fact, examples of that curious connexion between the liver and basal ganglia pointed out by Kinnier Wilson when he described lenticular degeneration. It is generally accepted that the cells in the brain which take the jaundice staining are dead and it may well be that the sequence of events is: liver damage; necrosis of cells in the brain; haemolysis; staining of liver and brain cells. By investigating the cholesterol partition in icterus gravis my colleagues Dr. A Rothe Meyer and Dr. E. M. Hickmans[36] have produced definite evidence that the liver cells are damaged in that disease and that the jaundice is not simply due to mechanical obstruction from bile stasis; actually it would be difficult to explain the occurrence of cirrhosis of the liver if the jaundice were not due to hepatitis.

In addition to staining of the basal ganglia we have also observed less severe staining of the cortex, a finding which suggests that mental deficiency may result. This suggestion is supported by the mental condition of some of the children who suffer from extra-pyramidal rigidity and athetosis following icterus gravis. Even stronger support has been received from recent work

in which 22 out of 124 random samples of ordinary low grade mental defectives proved to be the Rh positive offspring of Rh negative mothers; a number twice that which would be expected in a random sample.[37]

Polyostic fibrous dysplasia — a progressive disease of bone associated with pigmentation of the skin and, in the female, with precocious sexual development—was first described as a sequel of icterus gravis by my colleague, Dr. Frances Braid.[38,39] In our view the association of a number of these cases with grave jaundice is not fortuitous and the sexual changes are probably the result of damage to the cells of the hypothalamus by Rh antibodies.

Sometimes the temporary teeth, particularly the incisors, of an infant who has recovered from icterus gravis, are stained green; in my experience the permanent teeth have never shown such staining, nor have the children shown any evidence of kernicterus or cirrhosis. The enamel of the earlier temporary teeth begins to be formed between the 6th and 9th week and of the later ones during the 4th month of pregnancy and the enamel cells remain active for some weeks after birth. Actually, by the use of isotopes, it has been demonstrated that even fully formed enamel is not metabolically inert; death of the cell is, therefore, in this instance not a pre-requisite for staining.

In icterus gravis liver damage probably always occurs before and possibly also after birth, but I have not the remotest idea why cirrhosis of the liver, staining of the teeth, kernicterus with its sequelae extrapyramidal rigidity and mental defect are not invariably present. Unfortunately, even after the birth of the child, it is impossible to tell whether any of these manifestations will occur, although sometimes one may suspect the existence of kernicterus by a curiously high-pitched cry, especially if this is associated with convulsions.

The serum of every expectant mother should be tested against the Rh factor, both in her own interest should she need a transfusion after labour and in that of her foetus. This practice is already followed in some clinics. If the mother is Rh negative the father should be tested, and if he is Rh positive the stage is set for the occurrence of haemolytic disease in their children. This may not occur in the 1st pregnancy because the stimulus to produce antibodies is a cumulative one and may not be sufficiently strong in the early pregnancies; I have known its occurrence delayed until the 12th pregnancy. Providing a case of haemolytic disease has already occurred in the family, the father is heterozygous should any of the other children prove to be Rh negative, and then the chances for and against any subsequent foetus having the disease are equal; but if all the children are Rh positive, the father is probably homozygous, in which case the foetus and every subsequent child is certain to have the disease. So far it has not been possible to desensitize the mother or to neutralize her Rh antibodies, but if the baby is given an early transfusion with Rh negative blood its life can usually be saved, although it is doubtful if such treatment will prevent kernicterus or cirrhosis. I myself only advise transfusion if the baby is anaemic, but other people believe that a transfusion should always be given even if this means the previous removal of some of the child's blood. The degree of damage to the foetus varies directly with the time it is subjected to the effects of Rh antibodies and although a definite correlation has not been demonstrated between the titre of these antibodies in the mother's serum and the severity of the disease in the infant, it does seem reasonable, if the titre is rising, to perform Caesarean section or to induce labour as

soon as the foetus is viable. Recovery has followed Caesarean section at the 36th week followed by immediate complete substitution transfusion of the baby with Rh negative blood, but even this does not prove that kernicterus or cirrhosis can always be prevented, although the degree of haemolysis may be limited by the premature birth. Incidentally, this particular child has earned a degree of notoriety since a description of the operation has appeared in the *Woman's Home Companion* and the *Reader's Digest*.

Finally, an Rh negative woman requiring a transfusion for any purpose whatever should always be given Rh negative blood, since Rh positive blood may lead to the development of anti-Rh isoagglutinins although, as with pregnancies, this usually only occurs after repeated transfusions; moreover, Diamond has shown that the most severe forms of haemolytic disease occur in the children of women sensitized by transfusion.

Toxoplasmosis.

Toxoplasma, a protozoan genus, discovered in 1909, is a cause of disease in certain animals and was first shown to affect human beings in 1939. Toxoplasmosis occurs in different forms at different ages, and is sometimes the cause of certain nervous manifestations previously attributed to congenital defect or birth injury (Sabin[40]). In the congenital form, there are four main clinical signs, some of which may be absent: hydrocephalus or microcephaly; choroidoretinitis; convulsions or other signs of involvement of the central nervous system, and X-ray evidence of cerebral calcification. The disease can be transmitted to mice, chickens, guinea-pigs, rabbits and rhesus monkeys. The sera of rhesus monkeys and of human beings who have contracted the disease contain neutralizing antibodies which in man probably persist for several years; these afford an important aid in diagnosis since, if a rabbit is injected intracutaneously with a mixture of the patient's serum and toxoplasmatous material, any neutralizing bodies present in the serum attenuate or prevent the lesions of toxoplasmosis which would otherwise develop at the site of injection.

My excuse for discussing this rare disease is that this year I have had in hospital at one and the same time 3 infants who had been infected *in utero*. These cases are the first to be recognized in this country and the credit for this should go to my pathologist colleague, Dr. Baar. The first 2 cases were female twins born in the 32nd week of pregnancy. At birth L. H. weighed 2 pounds 15 ounces and A. H. 2 pounds 8 ounces, and they were admitted to hospital when 31 days old, each then weighing 2 pounds 10 ounces. The skull bones were poorly ossified, the fontanelles widely open and the sutures unclosed, but, except for slight jaundice, there were no signs of disease. After a week L. H. became lethargic, refused food and died 18 days after admission. At autopsy her brain showed hydrocephalus and closely packed lentil-sized granulations in the posterior horn and the middle part of the lateral ventricle. Histological examination revealed an extensive subependymal infiltration with large mononuclear cells which failed to stain with specific stains for astrocytes, oligodendroglia and microglia, and scattered between these cells were tiny spherical bodies apparently toxoplasmata. Animals inoculated with an emulsion of the brain did not show any definite changes when killed 8 to 10 weeks later. An emulsion of the brain of 1 of these animals was injected intraperitoneally into guinea-pigs and when these were killed, 1 animal showed numerous yellowish white nodules about the size of millet seeds in the lungs,

and enlargement and caseation of the mesenteric glands.

In the light of the postmortem findings in L. H., a careful examination was made of her sister's eyes, but evidence of choroidoretinitis was not found, nor did X-ray examination of the skull show any of the characteristic areas of calcification. This child progressed well for 6 weeks, but then developed a fatal pneumonia. An autopsy did not show any choroidoretinitis but did reveal moderate dilation of the cerebral ventricles and a few coarse warty granulations in the lateral ventricles which showed the same histological features as those in her sister. The liver of this child on section showed numerous yellow spots about the size of a millet seed or a pin's head. On microscopy these were found to be areas of miliary necrosis which presented on their periphery an infiltration with large mononuclear cells and lymphocytes and a fair number of tiny spherical bodies like toxoplasmata. Animals inoculated with material from the brain of this child showed nothing abnormal.

The 3rd case, D. L., was admitted to hospital when 14 days old because of inability to suck, due, it was thought, to birth injury. This child, which was poorly nourished, weighed 5 pounds 14 ounces. There was an extreme degree of moulding, the occipital overlapping the parietal bones, and the right arm was somewhat stiff and its movements impaired. An X-ray of the skull showed 1 or 2 isolated calcified areas which might be due to toxoplasmosis but are, I think, due to normal calcification. The condition of this child was always unsatisfactory and she died 6 weeks after admission. In the 2 weeks prior to her death she had cyanotic attacks which were accompanied by convulsive movements, but nothing was found to shake the clinical diagnosis of birth injury. At autopsy she was found to have hydrocephalus although ependymal granulomata were not seen, but histological sections showed a sub-ependymal cellular infiltration resembling that seen in the other 2 children. A guinea-pig inoculated with an emulsion of this child's brain died 10 weeks later; its liver and spleen were enlarged and both contained yellowish-white millet seed sized nodules and the mesenteric glands were enlarged and showed areas of caseation. Histologically all the organs involved showed granulomata, necrosis and the presence of toxoplasmata.

Both these strains have now been passed through over a 100 animals and always produced the same results. Inhibition of the intracutaneous reactions produced by these strains has been obtained with sulphathiazole and sulphadiazine; with penicillin a weaker inhibition occurred and none with sulphapyridine. Furthermore, positive neutralization tests have been obtained with the serum of A.H. (taken before death and stored) and with the serum of her mother to both strains. We have been unable to persuade the mother of the 3rd child to have the test performed. It is, therefore, certain that Mrs. H. had been infected with toxoplasma and although she had recovered she was a carrier of the disease and infected her babies *in utero*.

Toxoplasmosis can be attenuated in rabbits if sulphadiazine or penicillin is given at the same time as the animal is inoculated but not if given subsequently. Adults have recovered from the disease after taking sulphadiazine but its real value as a curative agent is unknown. We gave it to the 2nd twin but without success; nevertheless, should her mother again become pregnant, it would probably be advisable to give her a course of sulphadiazine or penicillin or both, although the optimal period of pregnancy for treatment and the duration of such treatment would have to be decided empirically.

I have now concluded my lecture and I hope that I have convinced you that both the nature and the nurture of the foetus largely depend on the adequate nutrition and good health of its mother throughout pregnancy, but that even these desiderata will not prevent the occurrence of certain genetic conditions. I trust also that you will agree that the evidence produced has shown that if, owing to inadequate maternal diet or disease the supplies to the foetus are insufficient, especially during the last third of pregnancy, or if, during that time, the foetus is infected *in uterò* or is born prematurely, the new-born infant will be immature, lack essential stores and may show evidence of disease or develop it shortly after birth; further, that such a baby is poorly equipped to withstand the trauma associated with labour or to combat the infections to which it may be exposed in the neonatal period.

Great advances have already been made in the prevention of foetal disease and death, but we are not yet in a position to say:

> "Never mole, harelip nor scar
> Nor mark prodigious such as are
> Despised in nativity
> Shall upon their children be."[41]

Indeed, far too many problems still remain unsolved and success in dealing with them will only be ours when we are completely gripped by a really great urge to achieve it.

> "Ah, but a man's reach should exceed his grasp
> Or what's a heaven for?"

and a far greater authority than Robert Browning once said, "The Kingdom of Heaven suffereth violence and the violent take it by storm". When obstetricians, paediatricians and social workers combine together in that spirit the future will indeed be radiant with promise. The full results of such a partnership will not be seen in my life time, but possibly from some Elysian field in company with Blair-Bell I may be permitted to witness them.

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NOTE—Recently Dr. C. M. Wenyon and Dr. A. Sabin (Cincinatti) have kindly examined specimens described as toxoplasmosis in this paper, and both say that the infective agent is not toxoplasma. The disease, therefore, is not toxoplasmosis but an encephalitis which clinically, serologically and by transmission to animals closely resembles it. Investigations are now in progress to determine the nature of the infective agent.

The Toxaemias of Pregnancy

BY

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ECLAMPSIA is a syndrome peculiar to pregnancy, which may be associated with any or all of the following manifestations: headache, disturbance of vision and even amaurosis, vomiting, oedema, a diminished secretion of urine, hypertension, albuminuria, coma and convulsions, while in fatal cases the hepatic and other lesions may present unique characteristics. The syndrome has been recognized for over 2,000 years and, although it occurs in every country, nevertheless exhibits a most marked geographical incidence. Eclamptic convulsions may occur in a woman tormented with headache, bloated with oedema and half human in appearance, whose scanty urine is loaded with albumin, and whose blood-pressure exceeds 200 mm. Hg., and they may also occur in a woman who appears to be in the enjoyment of good health, whose blood-pressure is not elevated, and whose urine is normal in quantity and contains no trace of protein.[1, 2] Further, the order in which the various signs and symptoms associated with the pre-eclamptic state manifest themselves varies from case to case, although hypertension most commonly precedes all others.[3]

It may therefore be postulated that any hypothesis which purports to explain the eclamptic syndrome in terms of one or more of its manifestations, no single one of which is inevitably a concomitant of eclampsia, and fails to offer a plausible explanation of all the known facts stands as self-condemned, and however ingenious should be ruthlessly discarded. Further, a sharp distinction should be made between hypothetical mechanisms which seek to explain such manifestations as oliguria, oedema, hypertension and convulsions, and a hypothesis which seeks to explain the genesis of eclampsia. Assuming that it could be proved that eclampsia was associated with placental infarcts, or with hyperactivity of the post-pituitary gland, or with an excess of some chemical substance such as guanidine, histamine, or tyramine circulating in the blood, real advance towards the elucidation of the cause of eclampsia would not thereby necessarily be achieved. It would be almost as logical to assert that pulmonary tuberculosis was caused by cavities in the lung. The real problem would be to determine the cause of the excess of these substances in the blood, why some pregnant women suffer from the toxaemias of pregnancy and others do not; why, indeed, a man should not have eclampsia. Any attempt to reduce this syndrome to such simple terms as a generalized angiospasm would fail to explain well-authenticated clinical facts, and would in any case represent the late mechanism and not the causal agency. In this connexion it would seem that the post-pituitary gland is more sinned against than sinning. Reviews of the literature[4, 5, 6, 7] reveal the confusion which exists, but it is noteworthy that most of the hypotheses advanced before 1930 have become obsolete.

Practical obstetric experience gained in such diverse centres as London, Cambridge, Dublin, Leeds, and Bangkok, together with extensive travel in the Far, Near and Middle East, forced me to recog-

nize the remarkable fact that eclampsia manifests a most marked geographical incidence.[8, 9] The incomplete and imperfect vital statistics in Oriental countries make it impossible for this, and much other knowledge, to be garnered in any save a personal manner, but he who ventures to travel beyond his own obstetric parochial boundaries must be prepared to pay a very heavy price. Dieckmann,[10] essayed the task of collecting statistics from many different centres, but it is very obvious that most of them are not comparable. He did, however, show that the incidence of eclampsia varies widely in different centres in the United States of America, and that the syndrome is either unknown, or very rare in Kenya, Uganda, Tanganyika, Persia, Alaska and certain other countries.

It is most erroneous to assume that any facile generalizations can be made, or that it can be asserted that the incidence of the toxaemias of pregnancy is low in Oriental countries, as compared with Europe and America. The incidence of eclampsia would appear to be high in many of the cities of India, whereas all authorities seem to be agreed that it is relatively rare in the agricultural villages, in which 90 per cent of the population lives.

I will here content myself with instancing two remarkable contrasts from my own experience. I cannot recollect seeing any serious case of hyperemesis gravidarum during the 3 years I was at the Rotunda Hospital, although the patients did not receive antenatal care. During 1 year at the Leeds Maternity Hospital a very considerable number of such cases was admitted, and although most of them responded to simple psychological treatment, 1 died and another developed the most severe polyneuritis I have ever seen, being unable to sit up in bed, or even to feed herself. One would hardly have anticipated that dour Yorkshirewomen would have been more "temperamental" than their Gaelic sisters who lived north of the Liffey.

During my 3 years in Bangkok, a city of some 700,000 inhabitants, I was in charge of the largest obstetric service in the country. It was, in fact, larger than all the others put together. Nevertheless I did not see more than 13 possible cases of severe toxaemia of pregnancy, and 7 of these, who were seen only shortly before they died, might have suffered from acute cerebral malaria, or some other tropical disease complicating pregnancy. I met all the missionary doctors practising in Siam and could hear of only 6 cases in their united experience, which extended over many years. It may also be noted that no system of purdah obtains in Siam, and that neither the Siamese nor the Chinese women evinced any repugnance to entering hospital. In sharp contrast to these remarkably low figures for Siam is the remarkably high incidence of the toxaemias of pregnancy in Ceylon, an island with just over half the population of Siam. The meteorological and living conditions are very similar in both countries, and yet Wickramasuriya[11, 12] reported that the incidence of eclampsia in Ceylon was 28 in every 1,000 live births, perhaps the highest in the world. According to Thiagarajah[13] this incidence had been reduced to 16.5 per 1,000 live births by 1939, but only at the expense of the pre-eclamptic incidence (including only those women with a systolic blood-pressure exceeding 150 mm. Hg.) which rose during the same period from 32 to 56 in every 1,000 live births.* Yet Dr. Thiagarajah assures me that the incidence of the toxaemias of pregnancy in his own private practice, as in that of his colleagues, is extremely low and

* For every 1,000 live births 120 pregnancies end either in miscarriage or stillbirth, and a further 120 infants die during the first year of life. The figures for India are much worse.

comparable to that which obtains in England.

The inescapable fact that eclampsia manifests a geographical incidence suffices to exclude from further consideration not a few of the hypotheses which have been advanced to explain its aetiology, seeing that by universal consent no micro-organism is causally involved. I was forced, against my will, to abandon Tweedy's hypothesis[14] which received convincing support from the marked success which attended the Dublin treatment of eclampsia. Since factors such as race, hygiene and sanitation could easily be excluded (the personal hygiene and the system of sanitation which obtain in Siam could not be held to be superior to those in Leeds or to differ markedly from those in Ceylon) the inevitable conclusion, so it seemed to me, was that it must be attributed to malnutrition. I confess, after the lapse of more than 15 years, that even after prolonged mental struggle this hypothesis then appeared to me almost as fantastic as it obviously did to those before whom I read the original communication. It nevertheless opened an entirely new and revolutionary approach to the study of the toxaemias of pregnancy.

I restated the hypothesis in 1933[15] in the following terms: "All the ailments and 'toxaemias' associated with pregnancy are caused by an absolute or relative insufficiency of some substance or substances in the diet, the most important of which is calcium, which leads to an inharmonious working of the various physiological processes of the body, and ultimately to hepatic dysfunction. The variety of ways in which hepatic dysfunction may be revealed is only limited by the number of physiological processes in which the liver is concerned." It seemed to me, for reasons which I shall elaborate, that calcium might be the main deficiency, but I stated in my original paper[9] "whether this suggestion be true or not in no way vitiates the truth of the main hypothesis". The reason these symptoms are peculiar to pregnancy is that the foetus makes nutritional demands on its mother who was suffering from multiple partial deficiencies, both of vitamins and minerals, before she became pregnant.

The purpose of this paper is to make certain observations on the mechanical factors which operate during pregnancy, to examine 2 of the "mechanisms" which have been suggested, (*a*) hyperfunction of the post-pituitary gland, and (*b*) placental infarcts, and lastly to evaluate the present position of the dietetic-deficiency hypothesis. Many of the observations will be made in summary form in order to encompass both comprehensiveness and brevity.

With the purpose of attaining precision of criticism, a list of eclamptic postulates is appended, against which any hypothesis may, and should be measured. It states known clinical facts and varies somewhat from that suggested by Whitridge Williams. Any hypothesis which fails to take into consideration a single one of the following facts cannot be considered worthy of acceptance.

The Eclamptic Postulates.

(1) Its geographical incidence.

(2) Hypertension.

(3) Albuminuria.

(4) Oedema.

(5) That any 1 or all of these 3 signs (2, 3, 4) may appear independently of the others, and that eclampsia may supervene in the absence of all of them.

(6) The peculiar and almost pathognomonic lesions associated with eclampsia and conversely, what is equally important, that the liver of a patient dying from eclampsia may present a relatively normal appearance.

(7) The higher incidence of the syndrome in association with primiparity and multiple pregnancy.

(8) The incidence of eclampsia in association with hydatidiform mole.

(9) That a woman may recover completely from an attack of eclampsia and subsequently give birth to an apparently healthy child. Conversely, that postpartum eclampsia may occur many hours after an apparently normal delivery, and apart from any prodromal symptoms.

(10) That death of the foetus is frequently associated with an amelioration of the toxaemic symptoms.

Mechanical Factors, and their Operation during Pregnancy.

Although it is impossible for many reasons to accept Paramore's hypothesis,[16, 17, 18, 19] which attributes the genesis of eclampsia to an increase in the intra-abdominal pressure, I was nevertheless inspired by his work to pursue certain investigations which led to the following conclusions: (*a*) that the weight and size of the uterus may be a factor in the causation of albuminuria, oedema, and pyelitis, and (*b*) that the liver may, in certain circumstances, be seriously damaged by the eclamptic convulsions, and possibly by the uterine contractions during labour.

The Intra-abdominal Pressure.

If an anaesthetized animal be tied on its back, the pressure in the ventral portion of the peritoneal cavity, by whatsoever means it be measured, is less than 2 mm.Hg.[20, 21] If this pressure be called p, then the intra-peritoneal pressure at any point in the cavity is equal to p + the component of the weight of the viscera acting on it. When the animal is at rest there is no such thing as *an* intra-peritoneal pressure, for it varies from point to point in the cavity, and the pressure at any one point changes with the position adopted by the animal. It is only when the diaphragm is fixed (when the breath is held), and the abdominal musculature is strongly contracted, as during coughing, vomiting, defaecation, and parturition, that the pressure becomes so elevated (50–95 mm.Hg.) as to justify the conception of an intra-peritoneal pressure. By the employment of local anaesthesia sterile liquid paraffin (normal saline solution is too rapidly absorbed) may be painlessly introduced into the peritoneal cavity of a dog, and this fluid allows continuous and simultaneous readings of the pressures in the dorsal and ventral parts of the cavity to be obtained. The introduction of a litre of this fluid does not significantly raise the intra-peritoneal pressure, which, it is interesting to observe may fall, wherever measured, below that of the atmosphere while the animal is actually eating food.[21, 22]

It is very clear that the pressures recorded in the stomach, rectum, and bladder (structures possessing their own musculature), are not those which of necessity obtain in the abdominal cavity. The simultaneously recorded rectal and intra-vesical pressures of a woman at term, while standing upright, correspond very closely, and exceed those similarly recorded in a non-pregnant women by 11.5 mm.Hg. When a woman, whether pregnant or not, bends forward the pressures in the stomach and bladder are thereby elevated, whereas the rectal pressure falls, sometimes by as much as 15 mm.Hg. Drinking a pint of water has no effect on the rectal pressure, but the removal of a pint of urine causes it to fall. Both the rectal and intra-vesical pressures of a woman at term fall to below that of the atmosphere when she is placed in the Trendelenburg, or even in the extreme lateral position. It is therefore evident that the very considerable difference between the rectal pressure of a pregnant woman at term and that of a non-pregnant woman,

when measured in the upright position, must be attributed to the weight of the uterus.[21]

Albuminuria. Urine is a modified ultrafiltrate of the blood-plasma. Ultrafiltration cannot in any sense be regarded as a simple sieving action, but is influenced by the nature and hydrogen-ion concentration of the plasma, the presence of salts, the concentration of protein in the solution, and the filtration pressure.[23] Each human kidney contains some $4\frac{1}{2}$ million glomerulotubular, or ultrafiltration units, and there is reason to suppose that they do not normally all function together, but enjoy rest pauses.[24]

It has long been known that a number of apparently healthy men from time to time pass albumin in their urine in clinical amounts, that certain foods (especially cheese), cold baths, and exercise may provoke albuminuria, while severe exercise may be associated with the presence, not only of protein but also of blood and both hyaline and granular casts in the urine.[25] I have shown that what is true of men is equally true of women, and it has always seemed to me an astonishing, and insufficiently appreciated fact, that albuminuria is more likely to be encountered in healthy college girls than in women who are less than 24 weeks pregnant.[26, 27]

A distinct variation in the permeability of the glomerular endothelium must be postulated, for during puberty both boys and girls may frequently pass protein in the urine.[27, 28] This increased permeability of the glomerular endothelium normally disappears before the 20th year, but may persist to a diminished degree for a further 10 years, and even throughout adult life. It may be provoked in 2 ways:

(1) By causing the individual to remain in an extreme lordotic position for from 30 to 40 minutes. Nearly every subject, whether male or female, passes albumin in the urine as the result of this insult, but as a rule the quantity is small. The individual belonging to the above group, however, passes a considerable quantity of protein. The albumin in all cases comes from both kidneys.[26]

(2) The ingestion of the whites of 10 eggs in 25 c.cm. of alcohol provokes albuminuria in the individual belonging to the above group, but not in normal subjects.[26] The size and weight of the uterus during the last weeks of pregnancy cause the woman to adopt the lordotic position while walking, and thus predisposes her to albuminuria.

Slow, deep breathing maintained for 30 minutes while standing in the upright position, likewise provokes albuminuria.[26] The act of respiration facilitates, whereas holding the breath impedes the return of blood to the heart, and thereby raises the general venous pressure. Sprinters hold their breath while running the 100 yards, and a Cambridge undergraduate, who subsequently became a member of our profession, actually ruptured his inferior vena cava while running this distance. It is also probable that this procedure causes a relative anoxaemia, and that both factors are concerned in causing the albuminuria. It may reasonably be assumed that the bulk of the uterus during the last few weeks of pregnancy causes an elevation and relative fixation of the diaphragm, thus impeding the return of blood to the heart, increasing the general venous pressure, causing some measure of anoxaemia, and predisposing the woman to albuminuria.

Contrary to expectation, the raising of the intra-abdominal pressure to 20 and even to 40 mm.Hg. had little or no effect on water diuresis, and did not provoke albuminuria.[22]

Pyelitis. A slight increase in the ureter pressure, associated with a low rate of urinary secretion, suffices to increase the dead space between the glomerular tufts and the ureter.[22] The weight of the uterus, and

in particular the pressure of the head of the foetus, might be expected to cause dilatation of the pelvis and calyces of the kidney, thus predisposing the woman to pyelitis, if a low rate of urinary secretion is maintained for any length of time. It may also be observed that a slight increase of pressure in the ureter may cause proteinuria.

Water diuresis. If an individual drinks a litre of water under controlled conditions he should pass approximately the same amount of urine within $2\frac{1}{2}$ hours. Should he for the duration of the experiment stand as motionless as possible in the upright position, he will pass little more than half that amount. If, however, his legs and thighs are firmly bandaged before he adopts the upright position, he will pass almost the same quantity of urine as the ordinary subject. It must be supposed that the absence of muscular contractions allows the blood to stagnate in the veins of the legs, and that the increased venous pressure so caused results in the escape of water from the blood-plasma to the tissues.[22] Firm bandaging of the legs largely prevents the stagnation of blood and the consequent transference of water. It can hardly be doubted that the weight of the gravid uterus, when the woman is in the upright, or sitting position, likewise causes stagnation of blood in the legs, and consequent transference of water from the blood-plasma to the tissues. This almost certainly accounts for the increase in the ratio of the night/day partition of urine during the latter weeks of pregnancy, which may exceed unity. This constant and abnormal escape of water from the blood plasma to the tissues by day, and its return by night, imposes no inconsiderable task on the mechanism, and should the colloid osmotic pressure of the blood plasma become significantly lowered, or any change occur in the permeability of the capillary endothelium, would result in oedema of the lower extremities. A certain amount of water retention probably always characterizes the latter weeks of pregnancy.

The Hepatic Lesions associated with Eclampsia.

The evidence would seem to suggest that the typical lesions particularly affecting the liver, which were described by Jürgens,[29] Pilliet,[30] Schmorl,[31] Konstantinowitsch,[32] and others, were almost invariably found in the organs of women dying from eclampsia up till the end of the 1st decade of this century. Of the sections made from the livers of 44 women who had died from eclampsia in different centres in England and Ireland, which I had the opportunity of studying, only those from 21 cases showed the typical fibrino-haemorrhagic necroses.[33] The older the section the greater was the likelihood of encountering them, and it does seem as if both the clinical manifestations and the pathological picture of eclampsia are changing. Indeed, the fear sometimes obtrudes itself that true eclampsia, like chlorosis, will disappear before its aetiology is discovered. Both Acosta-Sison[34] and Davidson[35] have reported that the livers of women dying from eclampsia may present a fairly normal histological appearance. The massive haemorrhages of the older sections strongly suggested their possible association with vitamin C deficiency.

It seemed possible that these pathological changes in the liver were caused by, rather than the cause of the eclamptic convulsions. Using a technique[33] which it is unnecessary to describe here, I succeeded in causing severe degenerative and necrotic changes in the liver, sometimes associated with haemorrhagic necrosis in the periphery of the lobules, simply by raising the intra-abdominal pressure in dogs and cats on several occasions to from 60 to 75 mm.Hg. for periods of half a minute. It was not

possible to reproduce all the mechanical factors which operate during an eclamptic convulsion, because the artificial raising of the intra-abdominal pressure causes a marked fall in the arterial blood-pressure.

Strauss and Maddock[36] were unable to confirm these results, which they attributed to the minimal amounts of chloroform which I employed. This conclusion cannot be entertained for the simple reason that the pathological changes I have described occurred in an animal narcotized with morphia, and that these lesions were independently confirmed by two eminent histologists. In a letter to me, Dr. Strauss confirmed my guess that his experimental animals had been kept for some time on a well-balanced diet, whereas mine had not. In my view the results reported by Strauss and Maddock add considerable significance to those I reported, and make it reasonable to suppose that a liver, impaired either by imperfect nutrition, or by some chemical agency such as chloroform, may be seriously damaged by the mechanical factors associated with eclamptic convulsions, and even by the " pains " of normal labour. This possibility enhances the difficulty of finding a safe anaesthetic for use during delivery.

It may therefore be asserted with confidence that the weight and bulk of the gravid uterus predispose a woman to albuminuria and oedema in 2 separate ways, and also to pyelitis, and accentuate any other deleterious influences which may be operating in the same direction. It is moreover clear that primiparity, multiple pregnancy, and hydramnios will enhance the operation of such factors, as was suggested by Paramore, although for quite other reasons. It is further probable that both eclamptic convulsions and normal labour pains may damage an already impaired liver, although the intra-abdominal pressure during a convulsion probably does not exceed that of a normal individual when straining at stool.

Hypothetical Mechanisms.

Most of the hypothetical mechanisms receive their sole support from conjecture, while that which attributes eclampsia to allergy is inherent with its own condemnation.

The Posterior Pituitary Gland.

Hofbauer[37] expressed the view that eclamptic convulsions were due to anaemia of the brain resulting from an arterial spasm caused by the vaso-constrictor action of the hypophysis-adrenal system. Anselmino and Hoffmann[38, 39] were the first to advance experimental evidence in support of this contention. Anselmino, Hoffmann and Kennedy[40] reported that ultrafiltrates from the blood of both pre-eclamptic and eclamptic patients inhibited water diuresis in rabbits, raised the blood-pressure of anaesthetized rabbits, even when injected subcutaneously, and expanded the melanophores of the frog's skin. Similar results were later published by Chunilal Mukherjee.[41]

At about the same time Cushing[42, 43, 44] advanced the thesis that the hypertension and fits associated with eclampsia could be attributed to pituitary basophilism, associated with a basophilic adenoma of the pars distalis. Siddall[45] assumed that although vitamin B_1 deficiency normally causes hypofunction of the post-pituitary gland, it exerts the opposite effect during pregnancy, and thereby causes the symptoms of the toxaemias of pregnancy. Lastly, Molitor and Pick[46] affirmed that if post-pituitary extract be injected intrathecally it inhibits water diuresis even when amounts are used which have no effect when injected intravenously, and that the inhibition so caused persists for a longer time.

Before summarizing my criticisms of

these experiments I would observe that water diuresis experiments demand an irreproachable technique and infinite patience. The only suitable experimental animal is the bitch, and results obtained from rabbits or rats are apt to be worthless, especially when small amounts of any antidiuretic activity are employed.

(1) Cushing's views no longer claim any general acceptance.

(2) Post-pituitary extract contains but 2 active principles, 1 which is oxytocic, and the other both pressor and antidiuretic. This extract causes an increased output of chlorides and stimulates intestinal peristalsis, whereas the toxaemias of pregnancy are associated with a retention of chlorides, and with coprastasis.

(3) Post-pituitary extract can cause proteinuria, but tends to prevent oedema formation.[47]

(4) Post-pituitary extracts cannot pass through the membranes used by Anselmino, Hoffmann and Kennedy.[48, 49]

(5) If 10 units of post-pituitary extract be added to normal blood, but little of the activity can be recovered from the ultrafiltrate of the plasma, even when suitable membranes are used. The extract seems to be largely adsorbed to the red blood-corpuscles.

(6) I spent many months in an effort to find evidence of a pressor substance in the blood of eclamptic and other patients suffering from marked hypertension. The blood was withdrawn into a vessel containing the requisite amount of sodium citrate, and surrounded by packed salt and ice in an outside container. The ultrafiltrate was obtained without delay and tested the same day, either on a decerebrate cat, or one under chloralose anaesthesia. This prolonged investigation was most tantalizing, for slight rises of blood-pressure caused by the intravenous injection of the ultrafiltrates tempted one to persist. Fearing that the pressor activity was being lost, some specimens of blood were collected straight into absolute alcohol at 0°C. Some time later Sir Henry Dale was kind enough to examine my tracings, and expressed the opinion that the recorded rises in the blood-pressure were without significance. These results were to be expected seeing that Høst[50] transfused 750 c.cm. of blood withdrawn from an eclamptic patient, immediately after a fit, into a patient suffering from carcinoma ventriculi without causing any untoward symptom, or any elevation of the blood-pressure. Page[51] proceeded a step further and transfused 400 c.cm. of blood from each of several patients suffering either from eclampsia or pre-eclampsia, into normal pregnant women without causing a significant rise of blood-pressure in any case.

The truly remarkable ease with which both Anselmino, Hoffmann and Kennedy,[49] and Chunilal Mukherjee[41] demonstrated a pressor substance in the ultrafiltrates of blood withdrawn from toxaemic patients (some with a blood-pressure not exceeding 150 mm. Hg.), can only be explained on the assumption that toxic changes had occurred in their samples of blood before ultrafiltration was performed.

(7) I did find evidence of antidiuretic activity in the ultrafiltrates of blood withdrawn from eclamptic and pre-eclamptic patients, but reserve my opinion as to whether it was caused by a true antidiuretic substance, or by the almost inevitable toxic changes which occur in shed blood.[48]

(8) I found that minimal inhibition of the diuretic response of a dog to 250 c.cm. and of man to a litre of water, was effected by the intravenous injection of from 0.00005 to 0.001 c.cm. of "infundin".* This means

* A proprietary post-pituitary extract made by Messrs. Burroughs, Wellcome and Co., and standardized in international oxytoxic units.

that the intravenous injection of that amount of post-pituitary antidiuretic substance which could effect a concentration of less than one in four milliards† in the blood plasma exerts a measurable effect on water diuresis in a healthy man or woman. Results of the same order were moreover obtained in women in the last weeks of pregnancy.

These profoundly interesting and truly astonishing results raise the issue in acute form as to whether the post-pituitary substance can be regarded as a physiological pressor substance. A careful perusal of the relevant literature reveals but one unequivocal fact, and that is the impossibility of causing a marked elevation of the arterial blood-pressure above the normal, in man or in dogs, by the intravenous injection of post-pituitary extract, for if large amounts are used the blood-pressure falls and death may ensue. The extract, moreover, constricts the coronary vessels and, according to Leschke,[53] causes sino-auricular block. The point, however, which I wish to stress is that at least 1,000 times that amount of the extract which inhibits water diuresis must be used to effect a pressor response which is but fleeting. It is impossible to imagine that nature would use the same substance to achieve two widely differing effects, particularly if the one activity demanded a thousand-fold increase of the amount required for the other. It is my view that the antidiuretic substance happens to be pressor when used in non-physiological amounts.

(9) Unlike Molitor and Pick,[46] I found that amounts of infundin which inhibited water diuresis when injected intravenously, exerted little or no effect when injected intrathecally. I moreover found that attempts at lumbar puncture, a difficult procedure in the dog, and even the shaving of the skin over the lumbar area, sufficed, not only to inhibit water diuresis, but also to cause proteinuria.[49] Verney and I[22] subsequently proved that these afferent sensory impulses inhibit water diuresis when the kidney is completely denervated.

The above evidence makes it abundantly clear that hyper-function of the posterior lobe of the hypophysis could not cause the syndrome of eclampsia. New and most interesting light has, however, been shed on the problem by Shockaert and Lambillon.[54] They reported that if a pressor substance (tonephin‡) was injected intravenously into pregnant women, it caused a much greater and more prolonged elevation of the blood-pressure in those patients who manifested toxaemic symptoms than in those who were normal. These important findings have been confirmed by de Valera and Kellar,[55] and by Browne.[56] Browne[7] thinks it possible that these results may be correlated with those of Byrom[57] who found that both gonadotrophic hormone and oestrogen are capable of sensitizing rats to vasopressin, and also with those of Smith and Smith,[58, 59, 60, 61, 62] who reported that the amounts of the anterior pituitary-like hormone in the blood serum and urine of patients suffering from the toxaemias of late pregnancy are abnormally high, whereas those of blood oestrin and urine pregnandiol are correspondingly diminished. It is also of interest to note that tolerance can be developed to this extract.[63] It is clear that a new field of investigation has been opened up, and that whereas it is reasonable to aver that the syndrome of eclampsia could not be explained by postulating hyperfunction

† Post-pituitary extracts some 100 times more potent than the standard powder used for assay purposes have been obtained, so that a concentration of 1 in 400,000,000,000 of such an extract in the blood plasma would suffice[52].

‡A proprietary preparation of the pressor fraction of post-pituitary substance, made by Messrs. Bayer Ltd.

of the posterior lobe of the hypophysis, it is not possible at present to delimit the consequences of hyperactivity of the whole gland.

Placental toxin hypotheses.

Seeing that eclampsia is peculiar to pregnancy any hypothesis which ascribes a causal toxin to the placenta merits particular interest. Stimulated by Veit's work Liepmann,[64] Freund[65] and others suggested that it arose in the normal syncytial cells of the placenta, but this view was soon discredited. Quite recently Page[66] has advanced the speculation that the toxaemic symptoms are due to ischaemia of the placenta, which does not find any support in the observations of Kellar and Sutherland.[67] The hypothesis, however, which has attracted the greatest interest and won the most support was introduced by Young.[68, 69, 70, 71] He maintained that both eclampsia and the albuminuria of pregnancy resulted from the absorption of the products of early autolysis of the placenta, which were liberated from recent infarcts "involving more than one-third of the organ and representing, it might be, 10 to 12 ounces or more of placental substance."[83] He believed that this conception was supported by the fact that extracts of the human placenta when injected into guinea pigs, caused convulsions, and significant pathological changes both in the liver and in the kidneys. The greatest tribute to the care and skill of his anatomical and histological investigations is afforded by the fact that those of Bartholomew and his fellow-workers,[72, 73, 74] published after the lapse of nearly 20 years, confirm most of his findings. Whereas Young attributed placental infarctions to some condition which interfered with the maternal blood supply, Bartholomew believes them to result from changes in the foetal circulation. Falkiner,[75] concluded that the association between infarcts of the placenta and eclampsia could not be regarded as fortuitous, but unlike Young and Bartholomew did not consider their aetiological significance proved.

Before further consideration of this hypothesis it is desirable to enquire whether there is general agreement concerning the association of placental infarcts with the toxaemias of pregnancy. Whitridge Williams and Stander have persistently denied any particular association. Siddall and Hartman[76] found infarcts of the placenta in 67.7 per cent of the 700 placentas they examined from consecutive confinements: Haffner[77] examined 400 placentas and found infarcts in 77 per cent of those obtained from patients who did not manifest toxaemic symptoms, and of these 30 per cent revealed fresh "haemorrhagic foci": von Ravenstein examined 260 placentas and found infarcts in 80 per cent of those removed from patients suffering from albuminuria, and in 66 per cent of those from apparently normal patients: whereas Clements,[78] after studying 500 placentas, concluded that there was no significant increase in the incidence of infarcts in the placentas removed from toxaemic patients. There seems, however, to be room for doubt as to whether these authors have rightly understood Young's contentions.

The association between placental infarcts and the toxaemias of pregnancy is clearly disputed, and even if it could be proved that they occurred ten times more frequently in placentas removed from toxaemic cases than in those removed from normal patients, it would still be necessary to show why they are not always associated with toxaemic symptoms. It might, moreover, have been supposed that a specific toxin would invariably cause similar effects, whereas the symptomatology of the toxaemias of pregnancy varies notably. It is, further, somewhat difficult to reconcile this hypothesis with the following clinical facts:

(*a*) that a woman may recover from antepartum eclampsia and subsequently give birth to a living child; (*b*) that postpartum eclampsia may occur many hours after delivery; and (*c*) that neither placenta praevia not threatened miscarriage are commonly associated with toxaemic symptoms.

The significance of Young's experimental work is diminished by the fact that Wooldridge[79] succeeded in causing intra-vascular clotting and haemorrhagic necrosis in the dog's liver by the intravenous injection of tissue fibrinogen. Schmorl[31] repeated these experiments and satisfied himself that he could thereby cause the specific changes in the liver, lungs, kidneys, and brain which he associated with eclampsia. Dieckmann[30, 81] also obtained similar results from the same procedure. On the other hand I found[9] that partial separation of the placenta of a pregnant bitch did not cause any toxaemic symptoms.

There is little doubt that toxic products could derive from the placenta, but there is reason to question the causal association of placental infarcts with the toxaemias of pregnancy. The placenta may be involved in physiological disturbances of the maternal organism and possibly plays some part in the reported alteration in the ratio of anterior pituitary-like hormone to oestrin in the blood of toxaemic patients.

In his most recent papers Young[82, 83] has postulated a "constant and imminent" X factor, or abortion factor, which he suggests may possibly represent a vitamin E deficiency. If he becomes confirmed in this view he will thereby adopt, and add his powerful support to the dietetic deficiency hypothesis. Curiously enough Bartholomew, the other champion of the significance of placental infarcts, likewise supports the dietetic deficiency hypothesis, for he believes the infarcts to result from hypothyroid activity, associated with an excessive intake of foods with a high cholesterol content. I have for a long time considered it desirable to give iodine to pregnant women, and by this simple means it should prove possible in most cases to stimulate the activity of the thyroid gland.

The Dietetic Deficiency Hypothesis.

All authorities are agreed that no woman requires any article of diet when pregnant that she does not normally need, but that pregnancy demands an increased intake, particularly of the vitamins and of certain minerals. It is manifestly absurd to imagine that any deficiency or deficiencies in the diet could cause any symptom whatever, and it is most obvious that any disease which can properly be attributed to specific deficiencies in the diet is in reality caused by the anabolic and katabolic processes of the body, operating in their absence. Apart from anabolism there can be no deficiency disease. It is undesirable to confuse the argument by enquiring whether the deficiency is due to deficiencies in the actual diet, to errors of absorption, or to inability to utilize the necessary substances.

In animal experiments it has been proved possible to cause barrenness, abortion at different stages of gestation, stillbirths, and the birth of sickly offspring merely by limiting, or withholding a single vitamin from the diet. It is not possible, for various reasons, to demonstrate in man the precise effects of the deficiency or absence of a specific substance in the diet, apart from scurvy and night blindness. Harris, Leong, and Ungley[84] express the generally accepted view when they state that conditioned partial deficiencies are likely to be multiple, and that multiple partial vitamin deficiency is not infrequently associated with the poor state of nutrition characteristic of so many diseased states.

I have already referred to the reasons

which led me to advance the dietetic deficiency hypothesis of the toxaemias of pregnancy. I have always believed, and have consistently maintained that these toxaemias result from multiple partial deficiencies, and that the most pronounced deficiencies might vary from country to country, and indeed between the different classes in any one community. "A great disservice has been done to the science of dietetics by those enthusiasts who stress this or that vitamin without considering the diet as a whole or the importance of personal hygiene. It is claimed that a complete, well-balanced, appetizing and easily digested diet, rich in the vitamins and in calcium, iron, and iodine, if given early in pregnancy, will prevent the onset of the toxaemias of pregnancy . . . and would increase the resistance of the woman to puerperal infection."[15]

There is every reason to believe on the one hand that the activities of the vitamins are to some extent synergistic, so that deficiency of the one enhances the untoward effects of deficiency of another, and on the other, that the operation of each vitamin is depressed by anaemia and ill-health. It is reasonable to assume that pregnancy, occurring in a woman already suffering from the unexposed physiological disadvantages accruing from prolonged multiple partial deficiencies of both vitamins and essential minerals, might be associated with any or all of the following accompaniments: hyper- or hypo-activity of the pituitary and adrenal systems, disturbances in the haematopoietic system, an altered ratio of anterior pituitary-like hormone to oestrin in the blood, hypoproteinaemia, infarcts in, or ischaemia of the placenta, pyrexia, an excess of such chemical substances as guanidine, histamine or tyramine in the blood, or indeed of any other physiological disturbance of the body. The normal temperature, the normal blood-pressure, the normal water balance, and the normal secretion of urine are each and all dependent on the operation of normal physiological processes which, if disturbed, might result in any abnormal manifestation. "*La fixité du milieu intériuer est la condition de la vie libre.*" I clearly laid too much stress on the toxins absorbed from the gut in my original paper, and have long since modified this view.

Whereas he who supports the dietetic-deficiency hypothesis is naturally anxious to elucidate the mechanism, or mechanisms which ultimately cause eclampsia, and recognizes that they may vary from case to case, the hypothesis itself is not primarily concerned with specific mechanisms, but with the aetiology and prevention of the toxaemias of pregnancy. It may be observed in parenthesis that both scurvy and night blindness were prevented centuries before mankind recognized the existence of vitamins. On the other hand the precise mechanism which immediately precedes eclampsia might be discovered without providing any knowledge whereby the syndrome could be prevented.

As it is now more than 15 years since the hypothesis was first published it is desirable to appraise its present position. In the first place it may be accepted that every antenatal clinic in the civilized world stresses the importance of the nutrition of the expectant mother, whereas in many not only milk, but calcium, iron and certain vitamins are given to those who attend. In the second place it has been accepted by a considerable number of obstetricians in different parts of the world, of whom the following may be mentioned: Siddall,[45] King and Ride,[85] Yasunami[86] (deficiency of vitamin B_1), Mendenhall and Drake[87] (deficiency of calcium), Strauss,[88, 89, 90] Bibb[91] (deficiency of protein), Bartholomew and his fellow-workers[72, 73, 74] (deficiency of iodine), McIlroy,[92] Nixon[93] (general deficiencies),

and, so far as I can gather, Young[82, 83] (deficiency of vitamin E).

It will be observed that these workers are inclined, for the most part, to attribute eclampsia to a specific deficiency, and a few observations will be made on each of the following deficiencies: calcium, vitamin B_1 and protein.

Calcium.

So far as my experience went when I first propounded the hypothesis, the incidence of eclampsia varied inversely with the amount of sunshine available to the expectant mother, and my thoughts naturally turned to calcium and vitamin D. Calcium salts form the greater part of the inorganic constituents of the bones and teeth, are present in nearly every tissue of the body, and are essential, not only to many physiological processes but to life itself, for in their absence the blood fails to clot and the heart ceases to beat. The amount of calcium circulating in the blood normally varies between 10 and 12 mg. in every 100 c.cm. of blood, but of this amount probably only 2 mg. exist as calcium ions, while 4 mg. are in some form of combination with protein or lipoids. The foetus demands some 8 g. during the last 4 weeks of pregnancy, an amount greatly exceeding that normally absorbed by the pregnant woman. There is a very delicate, and as yet imperfectly understood mechanism which controls the deposition, blood level and excretion of calcium, and the parathyroids would appear, in some respects, to act in opposition to vitamin D. Widdows[94] and Matters[95] agree that the blood calcium falls very considerably during the latter half of pregnancy, and that the placental blood contains a higher percentage of this mineral than the maternal blood. Matters, however, believes that this fall is occasioned not only by the demands of the foetus, but also by the increase in the amount of follicular hormone in the blood.

In 1928 I had some correspondence with Prof. Paul D. Lamson under whose direction Dr. Minot and Miss Cutler were working on the toxicity of carbon tetrachloride. These workers, while at Johns Hopkins University, had found it impossible to cause visible signs of poisoning in dogs by the oral administration of massive doses of carbon tetrachloride. When the work was transferred to Nashville the dogs died after the administration of less than one sixtieth of the amount of the drug which had had no apparent effect on the dogs at Baltimore. It was subsequently found that the mere addition of calcium salts to the diet made the dogs at Nashville as tolerant to the drug as those at Baltimore.[96, 97] Estimations of the blood calcium of both sets of dogs were nevertheless almost identical, and remained unaffected by the administration of calcium. The type and circumstances of these experiments do not allow of much room for error. Equally remarkable results were obtained by Greig,[98] in the treatment of cows suffering from "milk fever", a condition which in many respects most closely resembles eclampsia, by the intravenous injection of calcium gluconate.

It may therefore be postulated that calcium deficiency, even if unreflected by any change in the level of the blood calcium, could account for most, if not all of the toxaemic manifestations. The administration of calcium, if necessary by the intravenous route, almost invariably relieves morning sickness, hyperemesis gravidarum, cramps, excessive salivation, generalized pruritus, and exerts a beneficial effect in the chorea of pregnancy and on certain skin rashes.[15] I started the practice early in 1928 of giving calcium injections to patients suffering from eclampsia, but am satisfied that calcium therapy serves no use-

ful purpose when the damage resulting from its deficiency is too far advanced.

One possible objection to this view is that osteomalacia is not commonly associated with the toxaemias of pregnancy (Green-Armytage and Maxwell, personal communications). This condition is associated with a rapid drain of calcium from the bones to the excretory organs (parathyroid hyperactivity?), and not necessarily with a fall in the level of the blood calcium. It is most probable that the alteration of the calcium phosphorus ratio in the blood is of greater significance than the level of the blood calcium. I am still disposed to think that the most important and common single deficiency which leads to the toxaemias of pregnancy is that of calcium, but maintain as I originally did, that the dietetic deficiency hypothesis is in no way dependent on this view.

Vitamin B_1.

During my stay in Bangkok I was impressed with the fact that the incidence of beri-beri was much higher in pregnant than in either non-pregnant women or men, indicating that pregnancy demands an increased intake of vitamin B_1. I think I was the first to draw attention to this fact and to the possibility that the milder forms of gestational neuritis, wherever they occurred, might be occasioned by deficiency of this vitamin in the diet.[9] In 1933[15] I reported the successful treatment of a patient suffering from severe peripheral neuritis and manifesting choreic movements, by the addition of vitamins A, B and D together with calcium to the diet. In 1936[99, 100] I further reported that 4 patients suffering from a mild degree of peripheral neuritis had been completely relieved of their symptoms solely by the addition of from 1,500 to 2,250 units of vitamin B_1 to their diet, but that a further patient suffering from the same symptoms failed to improve until vitamins A and D were also administered. In 1935 Dr. Audrey Baker suggested that I should co-operate with Dr. Wright and herself in an attempt to determine whether the amounts of vitamin B_1 in the placenta and milk could be significantly affected by the ingestion of large amounts of this vitamin, and whether there was any correlation between the amount of vitamin B_1 in the placenta, the pregnancy toxaemias, lactation, and the development of the infant. This investigation had, for various reasons, to be postponed, but part of it has happily been carried out by Nixon, Wright and Fieller.[101] I moreover gave all toxaemic patients at St. Mary Abbott's Hospital from 1933 onwards, 800 units of vitamin B_1 daily, together with other vitamins and minerals.[102] Lastly in the report on the effect of calcium and vitamins A and D on the incidence of the toxaemias of pregnancy I stated that "These results strongly suggest that the other main factor in the prevention of the toxaemias of pregnancy is the vitamin B complex."

I have stressed my interest in the possible association of the vitamin B complex with the toxaemias of pregnancy before criticizing the claims of Siddall,[45] and more recently of King and Ride[85] that a "causal relation exists between a deficiency of vitamin B_1 and the occurrence of the toxaemias of pregnancy." Two mechanisms have been suggested whereby vitamin B_1 deficiency might cause eclamptic convulsions; (*a*) an excess of pyruvic acid in the blood, and (*b*) hyperfunction of the pituitary gland. The former lacks any serious evidence, particularly as convulsions are not a feature of beri-beri, while the second represents the most specious form of argument, seeing that beri-beri is normally associated with a low blood-pressure.

King and Ride[85] report that the number of cases of beri-beri complicating pregnancy

admitted to the Hong Kong Maternity Hospitals they visited rose from 49 in 1939 to 155 in 1940, a 3-fold increase. The number of cases of toxaemia of pregnancy rose from 200 in 1939 to 292 in 1940, an increase of 50 per cent. By 1941 the cases of beri-beri had only increased from 155 to 167, whereas the number of cases of toxaemia of pregnancy had risen from 292 to 416. It is thus very evident that both the number of cases of beri-beri and of the toxaemias of pregnancy increased very markedly, although not *pari passu*, during the years 1939 to 1940, and it is reasonably certain that the true incidence also increased, although it has always to be borne in mind that the population of Hong Kong is largely literally floating, and varies greatly.

King and Ride also state that of the 300 cases in which beri-beri complicated pregnancy, only 119 experienced normal pregnancies, whereas the remainder manifested toxaemic symptoms. This evidence, however, does not suffice to establish a causal connexion between vitamin B_1 deficiency and the toxaemias of pregnancy. In the first place the dry type of beri-beri was extremely common in Siam (I saw only 1 of the wet type) and no patient suffering from beri-beri developed any of the toxaemias of pregnancy. In the second place the 119 cases of beri-beri in Hong Kong who passed through a normal pregnancy are far more significant than the 252 who manifested toxaemic symptoms. If vitamin B_1 deficiency were causally associated with the toxaemias how could 119 women afflicted with beri-beri pass through normal pregnancies, whereas eclampsia is so common in Glasgow and other centres in Great Britain where beri-beri has never been diagnosed?

Perhaps the most convincing argument against this thesis comes from Ceylon, where beri-beri is very uncommon. Wickramasuriya[11, 12] reported an incidence of 28 cases of eclampsia in every 1,000 live births (an incidence nearly 4 times as high as the peak in Hong Kong); that it was nearly 4 times, and pre-eclampsia 10 times more common in subjects of hookworm disease than in those who were free from this infection; and that it was still more common in women suffering from chronic malaria. Anaemia is the most characteristic feature of both conditions. Haemoglobin estimations were made in 1,119 cases out of 2,741 consecutive admissions to the De Soysa Lying-in Home in Colombo, and of this series the average reading was less than 40 per cent, only 150 giving a percentage of 50 or over.[13] "The anaemia of ankylostomiasis is typically a secondary anaemia, hypochromic and microcytic in type, but as the disease advances a megalocytic type of anaemia may develop, and later, in the most advanced cases, and aplastic type of anaemia may develop."[103] Hookworm disease is normally associated with a low blood-pressure, and 90 per cent of infected women exhibit anarsarca and albuminuria during the latter half of pregnancy.

A heavy hookworm infestation, even exceeding 50,000 ova per gramme faeces is not, however, incompatible with good health and a haemoglobin percentage only 10 points below normal.[104] Further, some patients may be benefited by the administration of iron, even without removing the parasites.[105]

It seems to me that the evidence from Ceylon might be interpreted as proving a causal association between iron deficiency and the toxaemias of pregnancy, and with more reason than that from Hong Kong can provide in favour of a causal association between these toxaemias and vitamin B_1 deficiency. Anaemia, however, is not universally associated with eclampsia, neither is it always associated with ankylostomiasis. Neither is anaemia always due merely to iron deficiency, for haemoglobin formation

demands adequate amounts of vitamins B and C in addition to traces of copper and manganese. Further, the alarming mortality from the malaria epidemic in Ceylon in 1935 was attributed, by those competent to judge, mainly to the malnutrition of the sufferers.

All the evidence goes to prove that the anaemia of Ceylon is a nutritional anaemia caused by the lack of several essential substances, and that ankylostomiasis produces its serious effects only because its hosts are so inadequately nourished. The diet of the poor woman in Ceylon is deficient in all the vitamins and necessary minerals, and it may or may not be of significance that the soil is so poor in calcium that lime salts have to be fed to racehorses and other pedigree animals. I may here mention that Professor N. Mahfouz Pasha in a letter to me states that "the incidence of toxaemias amongst the higher and middle classes (in Egypt) is much lower than among the poor." Baird[106] reports similar conclusions from Aberdeen.

Now King and Ride[85] state that there was in Hong Kong in 1940 an "almost unimaginable state of overcrowding, malnutrition and distress among the lower classes from which most of our patients are drawn." It would therefore seem most reasonable to conclude that malnutrition was the underlying cause of the increase of the toxaemias of pregnancy in Hong Kong during the years 1940 and 1941, as it is clearly the cause of their high incidence amongst the poor women of Ceylon and Egypt, and that whereas vitamin B_1 deficiency apparently dominated the picture in Hong Kong, anaemia arrests the attention in Ceylon. This interpretation adds immeasurable significance to both sets of figures.

Although malnutrition is most evidently associated with poverty in Hong Kong, Ceylon and Egypt, it does not mean that wealthy people in Europe and America do not suffer from malnutrition, which in their cases is the result either of ignorance or of greed. Again the evidence strongly suggests that the incidence of eclampsia fell in certain German cities, not be it noted in the country districts, during the latter years of the first great war. This decreased incidence was associated with a decreased intake of meat and fats, and an increased intake of vegetables, and probably with an increase of physical exercise. It is a matter of opinion whether the increase in the amount of vegetables or the decrease in the amount of meat and fats was the more important factor concerned. There is also some evidence of a less reliable character to suggest that there was an increase in the incidence of eclampsia in Russia during the same years, which could definitely be correlated with an increased incidence of malnutrition.

Hypoproteinaemia.

Starling[107] was the first to demonstrate the significance of the colloid osmotic pressure in preventing oedema formation. It is evident that if the saline osmotic pressure in the tissues rises concurrently with a fall in that of the colloids of the blood-plasma below a critical level, oedema must occur. This tendency would be accentuated by the mechanical factors associated with pregnancy. The marked hydraemia associated with the latter half of pregnancy results in a fall in the colloid osmotic pressure of the blood-plasma, and according to Dieckmann and Kramer[103] the fall is greater in toxaemic than in normal patients. Strauss,[88, 89, 90] and Bibb[91] maintain that hypoproteinaemia, together with an excessive intake of salt, result in oedema and hypertension. The mechanism Strauss advocates might be the cause of oedema in some cases, particularly since so many obstetricians limit the intake of proteins

because they were so impressed with the evidence that eclampsia was associated with a high intake of meat. I have always maintained that a high animal protein diet can be allowed to patients suffering from the toxaemias of pregnancy provided adequate amounts of vitamins and the necessary minerals are assured.[102] I am equally satisfied that the ingestion of large quantities of meat requires an additional intake of these substances, failing which toxaemic symptoms are liable to manifest themselves. It was a tradition that the Assistant Master of the Rotunda Hospital was called out of the Christmas dance every year to wash out an eclamptic colon. The women of Dublin who entered the hospital with eclampsia before antenatal care was instituted and a low protein diet became fashionable, certainly did not suffer from hypoproteinaemia. Further, the incidence of eclampsia in Australia, where the women probably eat 2 or 3 times more meat than they do in Europe, is high. It must also be remembered that more than half the population of that Dominion resides in five large cities, where vitamins are not so plentiful as on the farms.

There is, moreover, no evidence that oedema *per se* can cause hypertension either during the course of an acute experiment or during the progress of a disease. An acute attack of malignant malaria at the 37th week of pregnancy may cause marked albuminuria, and the daily retention of some 6 pints of water for 3 days apart from any detectable rise in the blood-pressure. It has already been observed that both beriberi and ankylostomiasis may be associated with oedema and even anarsarca, and that in both conditions the blood-pressure is usually low. It cannot, therefore, be conceded that oedema causes hypertension, or that an abnormal hypoproteinaemia is the universal accompaniment of the toxaemias of pregnancy.

The evidence in favour of the dietetic deficiency hypothesis may be summarized as follows:

(1) It is difficult to propound any explanation of the geographical incidence of the toxaemias of pregnancy other than that which attributes them to malnutrition, seeing that by universal consent bacteriological agencies can be excluded. The report of King and Ride[85] from Hong Kong adds additional support to this view.

(2) All animal experiments prove the necessity for an increased intake of certain minerals and vitamins during pregnancy.

(3) Necrosis in the liver may be caused in dogs by feeding them on a cooked lean meat diet,[9] and in rats by a diet deficient in protein.[109]

(4) The mere addition of calcium to the diet of dogs can prevent death from carbon tetrachloride poisoning, while the intravenous injection of calcium gluconate can stop the convulsions, and prevent death from "milk fever," both in cows and in other domestic animals.

(5) It is believed by all authorities that multiple partial vitamin deficiency is common in England and throughout the world. Manifestations of vitamin and mineral deficiencies should therefore become evident during the course of pregnancy, and if the toxaemias of pregnancy do not represent these manifestations then the mother invariably escapes at the expense of the foetus.

(6) This hypothesis alone can satisfy the eclamptic postulates, and it alone promises any hope of preventing the toxaemias of pregnancy.

(7) It receives support from the success of antenatal clinics in preventing the actual onset of eclampsia. It is moreover possible that the marked improvement in the maternal and infant mortality-rates, which occurred in Great Britain between the years 1939 and 1944, may be rightly

attributed to the more balanced diet the poor women were forced to eat. It certainly could not have been due either to an improvement in the medical services or to absence of mental strain.

If, however, the toxaemias of pregnancy are due to faulty nutrition they can be prevented, and if they cannot be prevented the dietetic deficiency hypothesis, however strong be the arguments in its favour, must be rejected. The fact that they can be "cured" or mitigated by dietetic measures, while offering strong corroborative evidence in favour of the hypothesis does not serve to establish it.

Several dietetic experiments have been carried out, and the results will now be considered.

1934.

Mendenhall and Drake[87] gave 188 pregnant women additional calcium, and of this number only 2 developed toxaemic symptoms. Of the 230 control patients 30 developed toxaemic symptoms. The incidence of toxaemia was therefore 13 times higher in the control group than in that which received calcium.

1937.

Theobald[110] requested 50 women, selected at random and not more than 24 weeks pregnant, to take daily: calcium lactate gr. xx, together with capsules containing 11,000 I.U. of vitamin A and 450 I.U. of naturally occurring vitamin D. An equal number of women selected at random served as controls. Seven women in the treated group and 17 in the untreated group developed hypertension (systolic blood-pressure of 140 mm.Hg. or over). Half the number in each group were primigravidae, and among these the incidence of hypertension was 2 in the treated group and 6 in the control group.

1938.

Ross, Perlzweig, Taylor, McByrde, Yates and Kondritzer[111] supplemented the diet of 24 primigravidae kept "under the supervision of a competent matron" with certain food substances which included both vitamins and minerals. They concluded that the additional foodstuffs had exerted "no appreciable effect on the incidence of toxaemia."

1941. *The Toronto Experiment.*

Ebbs, Tisdall and Scott[112] conducted the following experiment in the Toronto General Hospital, in which 380 women, all of whom were less than 24 weeks pregnant, were divided into 3 groups: (*a*) those taking a poor diet throughout pregnancy, (*b*) those supplemented for the purpose of the experiment, and (*c*) those who normally enjoyed what was considered a good diet. Those selected for the supplementary diet were provided each day with 30 ounces of milk, 1 egg, an orange, 1 viosterol capsule containing 2,000 I.U. of vitamin D, and in addition a weekly ration of 16 ounces of factory tinned tomatoes and half a pound of cheese. Dried wheat germ containing malt and added iron was also given. The main and most striking difference in the results was in the columns for threatened miscarriage, premature birth, and stillbirth, but the pre-eclamptic incidence was not significantly affected by the improvement in the diet. If only these workers had supplemented the diet which they considered good, and compared that group with those patients taking an unsatisfactory diet throughout pregnancy, significant results might have emerged.

1942. *The People's League of Health Experiment.*

This was carried out in 10 London hospitals during the years 1938 and 1939.[113] In each hospital the women who enrolled at the antenatal clinic were divided into 2 main groups. Those in one group received

certain dietary supplements while those in the other served as controls. The women in each group were divided into primi- and multigravidae, and also into age-groups. The daily supplements consisted of: saccharated iron carbonate gr. xviii, calcium lactate gr. xxx, adsorbate of Vitamin B_1 (containing all the factors of the B complex and 200 I.U. vitamin B_1), vitamin C 100 mg., halibut liver oil m. vi. (containing approximately 14,000 I.U. of vitamin A and 800 I.U. of vitamin D), together with minute quantities of iodine, manganese and copper. The figures for the treated group, by whatever standards judged, were more favourable than for the untreated group, but were only just statistically significant in one age-group among the primiparae.

1943.

Browne[56] gave 960 I.U. of vitamin B_1 daily to 100 women during the latter half of pregnancy, and was unable to note any diminution in the incidence of toxaemia as compared with that of a similar number who served as controls.

1938–1944.

During this period I delivered 136 European women, of whom 133 consulted me early in pregnancy. I was able to satisfy myself that all of this latter group had lived on a good diet and were in comfortable circumstances. Many were representatives of the second generation who had lived most of their lives in Ceylon. They were by no means "hardy," but they did live open-air lives, and co-operated willingly in any advice they were given. I told them to eat what they liked so long as it agreed with them, to take a light and early supper at which they should avoid red meat, and to drink as much milk as they could. In addition I asked them to take Tr. of iodine m.x., and 4 to 6 osto-calcium* tablets daily throughout pregnancy, and 4 iron plastules† daily for a period of 6 weeks. The results were as follows: Twin pregnancy, 1; placenta praevia, 3; water retention, 1; albuminuria, 0; hypertension, 0 (any pressure exceeding 130/80 mm.Hg. was considered abnormal); Caesarean section, 0. Only 1 case was morbid as judged by the B.M.A. standard. All the infants, with the exception of 2 cases of placenta praevia at the 28th week, were born alive, including 1 case of extensive spina bifida which unfortunately survived operation. Only 1 infant, a Mongolian idiot, subsequently died in its 2nd year. The case of water retention responded to an intravenous injection of Mersalyl, and she has since had 2 normal confinements.

The three women who consulted me late in pregnancy provide a striking contrast. One was completely normal. One, a missionary, who came from England shortly before her confinement was due, developed a systolic blood-pressure of 173 mm.Hg., although her confinement was normal and her infant healthy. Her record shows that her systolic blood-pressure was 140 mm.Hg. 4 years earlier, when she first joined her Society. The 3rd came from India, a primigravida, aged 27. Early in her pregnancy she developed swelling of her feet and ankles, and had been forbidden to take any meat. Vegetables were difficult to obtain where she lived, and she did not take any milk. Ten days after she arrived in Ceylon she gave birth to twins, 8 weeks before they were due. Delivery was rapid and easy, and she appeared to be remarkably well on the following days. Nevertheless, exactly 88 hours after delivery she

* Each tablet contains Vit. D 500 I.U., calc. sod. lact. 0.5 gm. and calc. phosph. 0.16 gm.

† Each pastule contains ferri. sulph. ex. gr. v, and yeast gr. ¾.

developed coma, and later had more than 20 convulsions. If this was not post-partum eclampsia I do not know what it was, seeing that she has enjoyed perfect health ever since. She has not, owing to the war, had any other pregnancy. Both twins are alive.

If I am justified in excluding these 3 patients, then I can report 133 confinements, 132 living babies which survived, with no signs or symptoms of toxaemia other than that of water retention in 1 patient.

Discussion of these Results.

Seeing that I was the first to advocate such experiments I am bound to confess that they have signally failed to establish the dietetic deficiency hypothesis. An improvement in the quality and quantity of the diet may appear to effect a cure in a case of tuberculosis, a disease known to be caused by a specific bacillus, and it is most probable that the same measure might diminish the incidence of infectious diseases. The real value of these experiments is that they indicate the errors which must be avoided in subsequent experiments, and they are:

(1) The "good" diet must be commenced before the onset of pregnancy, and not a bare month before toxaemic symptoms are liable to manifest themselves. It was for this reason that I have reported my results from Ceylon, although the number of cases owing to the war was small, in the hope that similar co-ordinated investigations might be carried out by private individuals in England. It would be most interesting, and might prove very instructive, if data concerning the pregnancies of avowed vegetarians could be published.

(2) There is no reason to suppose that there is any disadvantage in giving vitamins and other substances in pill form but there is every reason to believe that many, if not most patients fail to take these "pills" regularly, if at all. This may have been the reason why the London investigation, clearly the largest and best planned of all these experiments, so clearly failed to provide any significant results. The women were given far too many "pills", some of which are indubitably prone to cause indigestion. This may also be the reason why the best reported results were achieved merely by the addition of calcium, with or without vitamins A and D to the diet.

(3) It is illogical to include multiparae as such in the experiment, because previous experiments have already separated them into 2 clearly defined groups, those that have, and those that have not manifested toxaemic symptoms. Providing accurate and comparable records of previous pregnancies are available, those that have manifested toxaemic symptoms may be divided into 2 groups, the one to receive additional foodstuffs, and the other to serve as controls.

(4) Browne[7] referring to the statistical report I published,[114] writes: "Theobald's contention has never been adequately answered and must be taken as correct. The only convincing explanation of his findings is that those women who develop hypertensive cardiovascular disease after toxaemia were originally predisposed to it, and would have developed it even though they had never become pregnant." This view is supported by Isenhour *et al.*[115] and by Barnes and Browne.[116] Vorzimer *et al.*[117] conclude that the toxaemias of pregnancy are associated with one or more endocrine stigmata. Classical eclampsia occurs more commonly in primigravidae and is not likely to recur in subsequent pregnancies, whereas the hypertensive is apt to manifest symptoms earlier and earlier in each successive pregnancy. The pertinent

question is whether the hypertensive, doomed to this condition, so far as we know, from the cradle, belongs rightly to the category of toxaemias of pregnancy. It may be that eclampsia represents the rapid and intensive operation of those factors which over a long period of years cause hypertension and Bright's disease.* It may be that hypertension, both in the pregnant and non-pregnant state may be prevented by adequate nutrition. Antenatal investigations may indeed do much to solve the riddle of cardio-vascular-renal pathology, but in the present imperfect state of our knowledge both groups should be kept distinct.

Conclusion.

An impartial examination of all the available evidence makes it difficult to resist the conclusion that the toxaemias of pregnancy are the result of an excessive drain by the foetus on inadequate maternal nutritional stores, aggravated by the untoward mechanical factors inseparable from pregnancy. The hypothesis has neither been established nor, for reasons which I have given, refuted by the direct experiments which have been reported. Seeing that this hypothesis alone offers hope of the elimination of the toxaemias of pregnancy it is of the utmost importance that further co-ordinated attempts should be made, either to establish its truth or to expose its fallacies. The death of a woman in the very act of fulfilling the highest destiny for which nature has fitted her is a peculiarly poignant tragedy, but the significance of the hypothesis to the race is of far greater import.

Although an eclamptic patient may give birth to a healthy infant, all authorities are agreed that a great wastage of foetal and neonatal life is directly attributable to the toxaemias of pregnancy. In my original paper[9] I claimed that "it is probable that human abortions, for the majority of which no adequate explanation can be offered, may be caused by deficiencies in the diet." There is, moreover, evidence which I will not elaborate, to suggest that foetal abnormalities, monsters, and hydatidiform moles may result from imperfect nutrition during the first 12 weeks of intra-uterine development. We have Browne's authority[3] for the statement that Ballantyne introduced antenatal care with the avowed purpose of preventing foetal abnormalities, and only towards the end of his life resigned himself to the conclusion that he could but benefit the mother. The wheel of fortune has turned a full circle, and evidence obtained from caring for the mothers has opened up possibilities of benefiting the foetus which exceed Ballantyne's wildest hopes.

The obstetrician is thereby not only thrown into closer co-operation with the paediatrician, but becomes closely associated with, almost affiliated to the Public Health services. The renaissance of obstetrics in Great Britain, attributable largely to the activities of the Royal College of Obstetricians and Gynaecologists, has made it all the more evident that the improvement in the maternal, foetal and neonatal mortality-rates in Great Britain could not have been accomplished apart from, and is in large measure due to these services. It is very clear that the prevention of ankylostomiasis and malaria will contribute more to the reduction of the maternal and foetal mortality-rates in Ceylon than any extension of the maternity services. The same observation would apply to India, China and many other countries.

The final elevation of the dietetic deficiency hypothesis to the theory of the

*The "ontogenesis" of eclampsia may represent a swift recapitulation of the "phylogenesis" of Bright's disease!

Encymonic Atelositeses* might make it possible, not only to eliminate the toxaemias of pregnancy, but also to lower the incidence of puerperal sepsis, reduce the abortion, stillbirth- and neonatal death-rates, and perchance to reduce the incidence of foetal abnormalities and monsters, and even of twin pregnancies and placenta praevia. Defective spermatozoa may be as associated with malnutrition as is contracted pelvis, and the " vital rubber " with which each child is endowed is in large part as dependent on the state of nutrition of the germ cells of its parents as on that of its mother during its intra-uterine existence. The penalties of nutritional defects are assuredly visited on the children unto the second and third generation.

England to-day is suffering sorely because the flower of her manhood was mown down on the blood-stained fields of Flanders more than 25 years ago, and that irreparable loss has been intensified by the staggering load of toil and sacrifice of the last few years. The country is tired mentally and physically and faces an unknown and difficult future. Babies are a priceless heritage which are needed as never before in our long history. Not one must be wantonly lost, and not one must be brought into the world without the endowment, both of the maximum vitality that its parents can impart, and the necessary environment, which in many cases the State alone can provide. The greatest single means of attaining these ends is to afford each individual an adequate supply of proteins, carbohydrates and fats, together with the necessary complement of vitamins and minerals. Who can foretell the diseases which will disappear from our ken if these ends are attained?

* Atelositesis denotes a state of nourishment which is imperfect either quantitatively or qualitatively (or both quantitatively and qualitatively). Mr. Cuttle could not think of Latin words which would be equally descriptive and for this reason " encymonic " must be employed rather than " gestational."[102]

Summary.

(1) The dietetic deficiency hypothesis postulates that the nutritional demands of the foetus on a mother suffering from multiple partial deficiencies, both of vitamins and essential minerals, deficiencies which usually antedate the pregnancy, are the underlying cause of the toxaemias of pregnancy.

(2) The bulk and weight of the pregnant uterus predispose the pregnant woman to albuminuria, oedema, and pyelitis, and accentuate the activities of deleterious influences operating in the same direction. Primiparity and multiple pregnancy enhance the operation of these mechanical factors. It is further possible that the eclamptic convulsions, and even the " pains " of normal labour may damage an already impaired liver. This possibility increases the difficulty of discovering an absolutely safe anaesthetic for use during delivery.

(3) In Siam, with a population of some 11 millions, when antenatal clinics hardly existed, and public health activities were in their infancy, eclampsia was all but unknown. In Ceylon during the same period the incidence of eclampsia almost certainly exceeded 28 per 1,000 thousand live births. In Hong Kong the incidence of the toxaemias of pregnancy increased by over 100 per cent between the years 1939 and 1941, and was associated with an evident increase in the numbers suffering from malnutrition.

(4) A clear distinction should be made between mechanisms which are thought to cause toxaemic symptoms, and hypotheses which purport to explain the genesis of eclampsia. Of these mechanisms two have won the greatest measure of support. The

one attributes the toxaemic manifestations to hyperactivity of the post-pituitary gland, the other to the toxic autolytic products which derive from recent infarcts in the placenta.

(5) Reasons are given to show that hyperactivity of the post-pituitary gland could not cause the manifestations of eclampsia, and to suggest that post-pituitary extract does not contain a physiological pressor substance.

(6) Although the autolytic products of the placenta are undoubtedly toxic, the available evidence suggests that the toxaemias of pregnancy cannot as a rule be attributed to placental infarcts.

(7) If it be true that hypertension is as common in single as in married women who have borne children, and that a number of women who suffer from hypertension during pregnancy would have developed it whether or not they had become pregnant, then it clearly follows that such women should not be classified to any of the columns of the toxaemias of pregnancy. It may well be that adequate nutrition might prevent the development not only of hypertension, but also of the cardio-vascular-renal sequence which ends in Bright's disease, but in the present state of our knowledge the confusion of "essential" hypertension with classical pre-eclampsia can but obfuscate the issue and impede the efforts to elucidate the cause of both conditions.

(8) The dietetic deficiency hypothesis alone satisfies all the eclamptic postulates. The evidence in its favour, and in particular that afforded by the geographical distribution of the toxaemias of pregnancy, appears to be very strong. Nevertheless its proof awaits the satisfactory demonstration that they can be prevented.

(9) Suggestions are made as to why the dietetic experiments so far made have signally failed to establish this hypothesis, the most important of which is that the "good" diet must be given before pregnancy commences.

(10) The saving of maternal life which would result from the elimination of the toxaemias of pregnancy would be great, but the consequent saving of foetal and neonatal life would be of immeasurably greater significance, for good or for ill, to mankind.

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The Obstetrical Forceps: Controlled Axis Traction

BY

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MUNRO-KERR[1] describing the forceps operation writes:—

"The amount of traction which can be exerted by the forceps, especially axis-traction forceps, is enormous, because, if well applied, the blades grasp the head so exactly. It is this perfection of design which makes the obstetric forceps such a dangerous instrument in the hands of the inexperienced and the aggressive accoucheur, who does not appreciate his own limitations and the limitations of the instrument. I have seen an accoucheur with his feet up against the couch, even applied to the buttocks of the patient, exerting all his strength. I have occasionally exerted a considerable amount of force myself, although I believe this is seldom justifiable. The instrument is, then, as a rule, being used in a wrong manner, or too early, or is unsuitable in the particular circumstances." Some years ago Sir Comyns Berkeley[2] offered the criticism that women might very well pray "*From* the obstetrical forceps, good Lord, deliver us." It must be recognized, however, that just so long as the forceps operation is dependent on individual judgment, disasters are inevitable and the obstetrical forceps will continue to take their toll of life and well-being. The instrument is not infrequently used under conditions which require the application of what most authorities describe as "tentative traction," the implication being that the use of force beyond the tentative will result in stillbirth and serious injury to the mother. Unfortunately the estimation of tentative traction depends entirely on individual judgment—a peculiarly human faculty subject to the variation and error of all human attributes. Yet there can be no greater betrayal of the scientific method than resort to the force described by Kerr, for if delivery is possible with brute strength it can always be more safely accomplished by knowledge and art.

Can we put a limit to the force which can safely be used in a given case? With experience of controlled traction it seems possible to acquire a knowledge of the limits to which the traction force can safely be raised.

MEANS OF CONTROLLING TRACTION FORCE.

The idea of measuring traction force is no new one, and rather cumbersome instruments were devised by the earlier French obstetricians who were chiefly interested in the amount of force necessary to effect reduction in the diameters of the foetal head in cases of disproportion.

The included diagrams show the construction of instruments which have been found to give accurate control of traction force. They are adequately represented in the illustrations and require little more description. The springs in each are of stainless steel and their temper is not affected by boiling. Both instruments are chromicized so that they can be boiled without fear of corrosion. The round spring handle—Figs. 1 and 1a—can easily be dismantled and reassembled and is a very simple mechanism. The coach-spring handle, Fig. 2, does not have any detachable parts, and

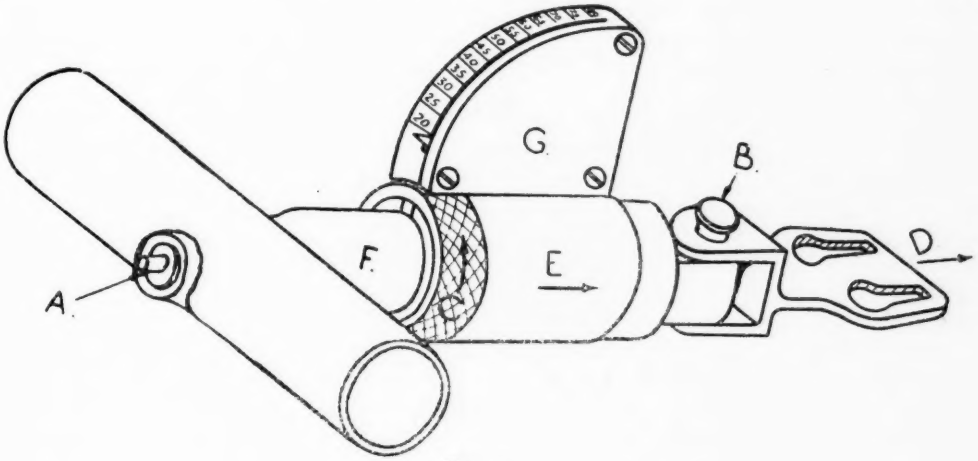

FIG. 1.

Traction handle No. 1. Spiral spring type.

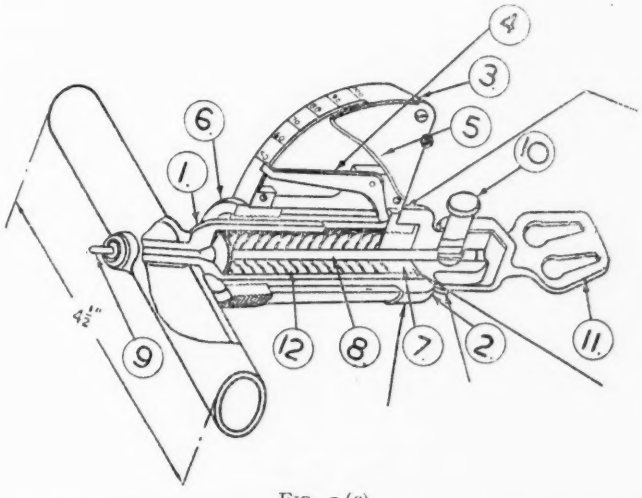

FIG. 1 (*a*)

Traction handle No. 1. Spiral spring type, casing partly removed

Part No.	Description	Part No.	Description
1.	Handgrip and inner sleeve.	7.	Screwed plug in inner sleeve.
2.	Outer sleeve and eyelet piece connexion.	8.	Pre-loading spindle.
3.	Scale case and band.	9.	Pre-loading push rod.
4.	Indicator.	10.	Pre-loading maintaining pin and pivot.
5.	Scale case cover.	11.	Eyelet piece.
6.	Knurled nut on outer sleeve.	12.	Spring.

Initial Loading Rod. Push rod with conical end is used for compressing spring to initial load of 50 pounds. When push rod is pushed in, pivot pin (10) is pushed up until edge of hole through pin engages with recess in pre-loading spindle, thus maintaining compression.

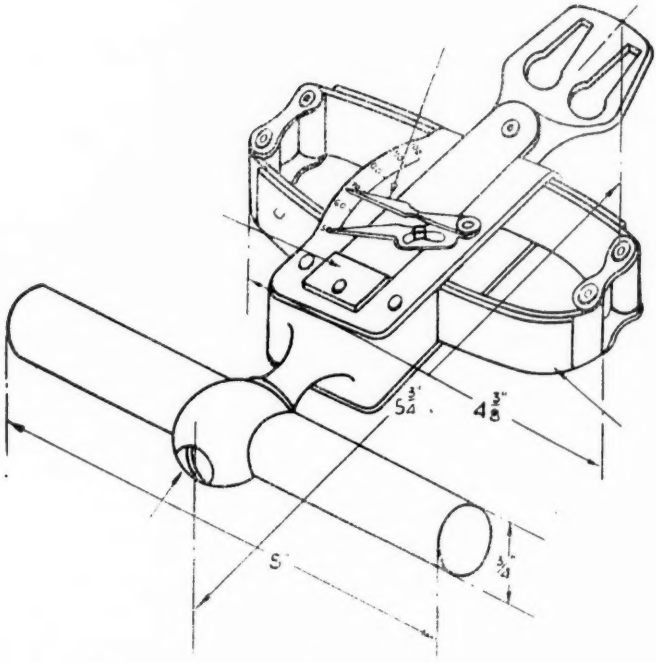

FIG. 2.

Traction handle No. 2. Leaf spring type.

requires no more care than the solid handle. There is some advantage in keeping the distance between the traction bar and the connecting link as short as possible but it has not been possible to maintain this, and both instruments are about 2 inches longer than the orthodox handle. Calibration of the recording scale is accurate but requires checking from time to time although variation in the recording mechanism is most unlikely, even over long periods of time, if the instrument is made from good metal and expertly fashioned. As will be shown below there is no necessity to record forces below 50 pounds, except as a matter of interest. Similar traction handles could be designed for any type of forceps.

In use, one finds that the traction force is applied slowly to the head and the impression is gained that the same power cannot be used as with the solid handle. This, however, cannot be the case since the same force is required by either instrument to effect delivery, and the apparent loss of power is simply due to the fact that, with the spring handle, the force is more slowly and therefore more safely raised. With experience this feeling of loss of power disappears and is replaced by one of confidence.

It is doubtful if even the expert technician can guess to within 20 pounds the force which he employs, although we have it on good authority that the expert technician should never guess. It is probable that many never think of traction in terms of measured force at all nor do they relate it in any definite way to the compression

force applied to the foetal head. The accoucheur simply gauges the resistance to descent against his pull and frequently he will attempt a little more force than is compatible with absolute safety.

Experience is the only guide in these cases and as Franklin[3] puts it "Experience keeps a dear school but some people will learn in no other, and scarcely in that." It is very doubtful if any single traction effort can be raised slowly and smoothly without visual control, for even when that control is supplied it is only with practice that the pull can be gradually increased. The "cushion" effect of a spring introduced between the traction force and the resistance makes it impossible to apply a sudden "jerk" to the head or to use any more force than is necessary to its descent. This is, in itself, a great advantage.

There is little point, however, in measuring traction force unless it can be related to the compression of the foetal head and the distension of the genital canal. It is impossible, at present, to reproduce experimentally the forces acting on the foetal head during any phase of labour and it is particularly difficult to arrive at any estimation of those components which are supplied by the resistance of the birth canal itself. The traction force is determined wholly by the resistance to descent of the head, the greater the resistance the greater the pull, and with the forceps applied to the sides of the fully-flexed head, the force compressing the foetal skull will bear a more or less constant relation to the traction force. Delors[4] estimated the compression force to be one half of the traction force but does not give any details of how he arrived at this estimate. For the purpose of estimating the traction force that can be applied with safety to mother and foetus, it is unnecessary to know either the maternal resistance or the amount of the compression force involved although a knowledge of these would greatly ease the solution of what is, perhaps, at once the most difficult and the most important problem in the mechanics of labour. Moreover, there is considerable variation in the capacity of different foetal skulls to withstand compression. It has long been known that the premature head does not readily withstand compression, and prematurity is always a contra-indication to forceps delivery. Holland,[5] discussing the stresses and strains to which the foetal head is subjected during labour, writes "It is impossible during the course of labour, in any given case, to analyze the exact nature of cranial stress and to measure accurately its intensity or to predict its effects." Nevertheless it is possible to demonstrate a definite relation between the traction force and the force compressing the foetal head and to arrive at an approximation of the maximal force which can be exerted on the forceps with safety to mother and infant and beyond which stillbirth and severe maternal lacerations would seem inevitable. This statement is qualified by the following requirements:—

(1) That the foetus be an average full-time one weighing between 7 pounds and 8 pounds.
(2) That the head be fully flexed and the long diameter brought anteroposteriorly.
(3) That the forceps be applied to the sides of the head.

Foetal Death and Compression Force.

The work of Holland on intracranial foetal injuries during labour is among the classical contributions to obstetrics. He regards "The septa of the dura mater as ligaments of the bones of the vault restraining excessive alteration in the shape of the head during labour. When the head is subjected to excessive stress the strain thrown on the septa may be so great that

they tear." Holland admits that it is impossible to assign the exact cause of death in those cases. Tearing of the septa is unlikely by itself to cause foetal death and in fatal cases is associated with rupture of blood vessels, compression of the vital centres and consequent anoxaemia. The foetal heart may continue to beat after the vital centres have ceased to function. This it does by virtue of its own inherent rhythmic activity. The tearing of the septa must be regarded as the result of excessive force but the point to be determined is whether this occurs before or after the lethal effects of compression are produced. Compression effects are often in evidence in the absence of actual tearing and it would seem to be a fair inference that a force less than that necessary to effect rupture of the septa may still be sufficient to cause foetal or neonatal death.

If sections of dura mater, 1 inch square, are removed from the recently dead full-time foetus the tensile strength of the membrane can be measured in different directions of tension. The sections tested were removed from the dura mater underlying the parietal bones. In the anteroposterior direction rupture occurred with an average force of 10 pounds, in the transverse direction it occurred with an average force of 7 pounds. The falx cerebri is comparatively fragile and will not withstand a tension force greater than 2 pounds in any direction. The tentorium cerebelli was not tested.

The maximal tensile strength of any section of dura tested was 13 pounds in the anteroposterior plane and in this instance the foetus weighed 8 pounds 8 ounces. It has not been possible to compare the tensile strength for different weights but the impression has been gained that the strength of this membrane is related to weight, being stronger in the heavier infant. The falx shows remarkably little variation although it is likely that, as Holland points out, it is stronger in some parts than in others. Regarded from the point of view of a ligament supporting cranial stress it must be held that its strength is determined by its weakest part. The sections tested were cut from that portion which lies between the two cerebral hemispheres and the two fontanelles. On removal they were immediately placed in saline and were kept moist during the whole period of testing. Fixing in the clamps was facilitated by immersing each section in saline in a watch-glass and spreading with forceps, the forceps picking up only the cut edges. If the section tore along the line of clamping it was discarded and only when rupture of the fibres occurred somewhere between the clamps was the result regarded as representing the breaking strain.

If we assume that a force delivered at the periphery of the skull is reduced or absorbed, as it were, by moulding to a force less than 7 pounds before it is communicated to the dura, and to less than 2 pounds, before impinging on the falx, then it would seem that in normal labour the foetal skull is so adapted to absorb normal compression force that the actual brain substance largely escapes pressure and this is exactly what we would expect.

It is recognized that these forces are not strictly comparable, for one is in terms of compression and the others in terms of tension, but having regard to the mechanism of moulding and the intimate relation between the two forces this comparison would appear valid. In normal labour the incidence of the compression forces is in the main upon the girdle of contact, that is, in the suboccipitobregmatic circumference, and a compensatory elongation of the mentovertical diameter takes place. It is likely that this elongation is directly proportionate to the compressing force, but in any case the measurement of this force is

not absolutely necessary for our purpose because we know that, when the limit of safe moulding has been reached, the strain falls on the falx, and that this structure offers a practically negligible resistance. In consequence of these facts we cannot but assume that, in normal labour, whatever compression force is exerted on the foetal skull must be completely dissipated in the movements of elongation and moulding and within a certain limit, for if the force continues to act beyond this limit its magnitude need only be very small to effect rupture of the falx. Rise of intracranial pressure probably begins when the limit of moulding has been reached, and in the interval between this event and the rupture of the falx the foetus may die. A factor which must be considered is the elasticity of the falx, and in cases in which this is very great, compression and death may be effected without rupture. There is no evidence to indicate that rupture of the dural septa may not be uncommon and compatible with survival, but it is significant that scarring of the septa has not been reported as a feature in the pathology found at autopsy in infants. The tension which intracranial structures are able to support forms some index of the limit of moulding and of these, the falx offers most likelihood of accurate measurement.

The skull responds to the compression force by altering its shape, but, when the limits of this alteration are reached, the force is communicated to the brain itself and here the impact of a force equivalent to something less than the tensile strength of the falx is apparently sufficient to cause foetal death. It is unlikely that the dural septa can have any marked effect in restraining moulding of the skull and it is probable that they merely divide the cranial cavity into compartments for the subdivisions of the brain.

The structure of the foetal brain is such as to allow it to follow easily the alterations in shape of the protecting skull. The lining membranes and blood vessels show great accommodation to tension before actual rupture, but the delicate nature of many of these structures, particularly the pial blood-vessels, suggests that interference with their function would be accomplished by a very small compression force and it may be that anoxaemia is the important factor in producing death. The work of Chute and Smyth[6] shows that brain tissues have a very rapid gaseous metabolism and that interference with the blood flow through the brain rapidly checks its function. It is probable that this effect has been reached before the tearing of the septa and the gross haemorrhagic lesions which are sometimes found at autopsy.

In stillborn cases of breech presentation where the aftercoming head has been delivered with difficulty the writer has found few macroscopic lesions. Microscopically the outstanding feature was that almost all the capillaries in the brain, especially in the medulla, pons and cerebellum, were distinctly engorged. The veins were also distended almost to rupture, and in slightly varying degree. In certain areas rupture had occurred with local extravasation, rhexis and local haemorrhage. Where the areas involved were relatively large the blood tracked along the perivascular spaces and in some instances reached the subarachnoid space where meningeal vessels showed similar changes. The cause may have been trauma and compression and partly lack of oxygen. Holland found that haemorrhage was always confined to the area drained by the vein of Galen and its tributaries and he believes that the rupture of the vessels is due to tension and engorgement.

The evidence suggests, however, that foetal death is produced by comparatively small compression forces reaching the brain

and that gross lesions are the results of these forces continuing to rise after death.

The Experimental Problem.

If the moulding of the foetal skull provides a mechanism whereby normal compression force is absorbed and prevented from reaching the brain, and, if only a small compression force applied to the brain is required to produce foetal death, it follows that by determining the force, which, applied through traction to the skull, first appears within the cranial cavity, we arrive at an approximation of the maximal safe traction force. The measurement of this force is scarcely practicable in the labour room and one must have resort to methods of experiment which are not without fallacy. Nevertheless they reveal interesting information and substantially support the belief that a knowledge of the traction force alone can be a safe guide in forceps delivery.

In each experiment a full-time normal foetus, weighing between 7 pounds and 8 pounds, was used. Death had occurred during labour or soon after delivery and from such cause as prolapsed cord or other condition not associated with extreme moulding of the head. A foetus born by Caesarean section provides the most reliable experimental data. The time elapsing between death and the experiment was only a few hours at the most. A wide-bore needle was introduced into the cerebrospinal canal in the lumbar region and its entry into the canal verified by withdrawing a little cerebrospinal fluid. The body of the foetus was then placed on a small platform so that the head hung down, over and behind a vice. Clamped in the vice was a ring of stout rubber with a central aperture 4 inches in diameter and the outside wall reinforced with an angle iron to allow clamping in the vice. Fixation of the head during powerful traction was at first a difficult problem until a small rubber tyre was found to suit the purpose admirably. The forceps was applied to the sides of the head and the head gently drawn into the aperture until resistance was encountered. The position of the needle in the cerebrospinal canal was again verified, and the needle then connected with a water manometer which was fixed with the water level approximately the same as the point of entry of the needle into the canal. Since the cerebrospinal fluid is not under initial tension, and displacement of the water only begins with application of the traction force, it is important that the same position of the manometer relative to the foetus be observed in each case if comparison is to be made accurately. Traction was now begun and the force gradually raised (Fig. 6).

The traction handle for this work was improvised from a Salters No. 20 spring balance. All unnecessary appendages were sawn off the iron box containing the spring. A connecting link was fixed with a small nut and bolt to the spring lever and a U-shaped bar riveted to the sides of the box so that the handle bar passed behind and equidistant from either end allowing a comfortable, powerful grip. The scale of this balance is marked off in 1 pound units and registers up to 100 pounds. This particular improvisation has been used in the labour room and although it has been frequently boiled is still accurate.

The traction force was raised by increases of 10 pounds at a time, the traction being maintained at each level until the water column in the manometer became stationary. The reason for doing this is described below.

Only 1 foetus, stillborn by Caesarean section, was available for study. Pulsation was present in the cord when extracted and the indication for section was placenta praevia. This foetus weighed 8 pounds 8 ounces, but is included here to show how

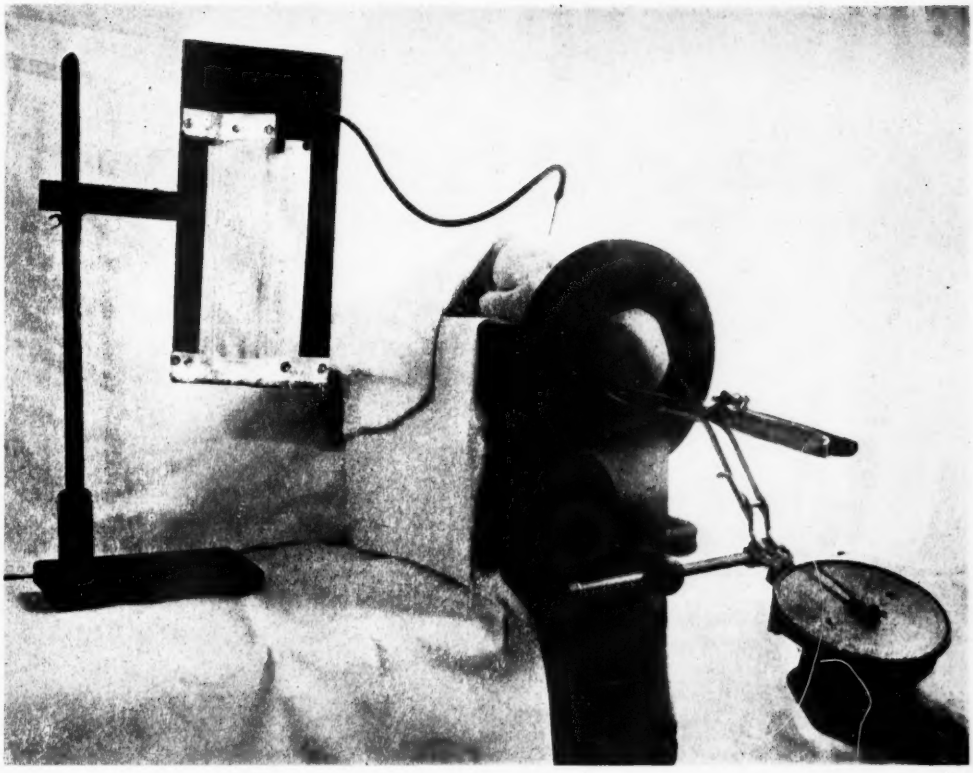

FIG. 6.

Experimental method of recording compression effects of traction force. A few slight alterations have been made for pictorial purposes. The improvised resistance consists of a rubber tyre with an inner circular iron bar. The resistance can be increased when necessary by the use of rubber wedges. Note the traction handle. The large spring and scale of this instrument allow a very fine control over traction force.

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traction force may affect the completely unmoulded head. As the traction force was increased from 0 up to 60 pounds the water in the manometer rose slowly; thereafter it rose more rapidly with each successive rise in force until between 90 and 100 pounds when it became stationary. This rising intracranial tension is shown graphically in Fig. 3.

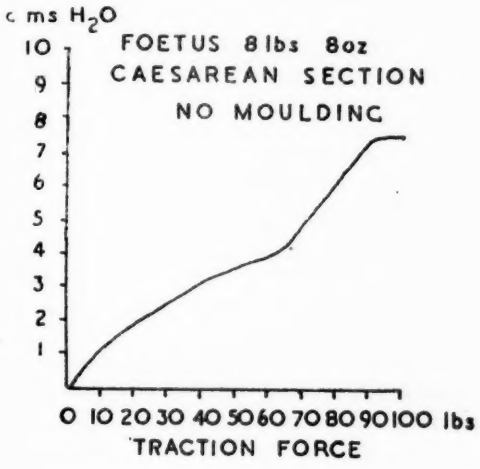

FIG. 3

In all other cases the results are probably influenced by some degree of moulding but they are no less valuable on that account, for in practice it is only very rarely that the forceps are applied to the unmoulded head. The skull which has been moulded by the natural forces would not be expected to withstand the same amount of compression force as the unmoulded head. This is borne out, at least in part, by the clinical evidence of a high stillbirth-rate when trial of labour is terminated by the forceps, and is substantiated by the experimental work, such as it is.

When the head is not unduly moulded the rise is slow up to 50 pounds, more rapid from 50 pounds to 70 pounds with little or no rise thereafter. This type of rising intracranial pressure is shown graphically (Fig. 4), and was found in 3 cases.

In 2 other cases without marked moulding the rise of pressure was fairly constant until between 70 pounds and 80 pounds when a further rise could not be obtained (Fig. 5).

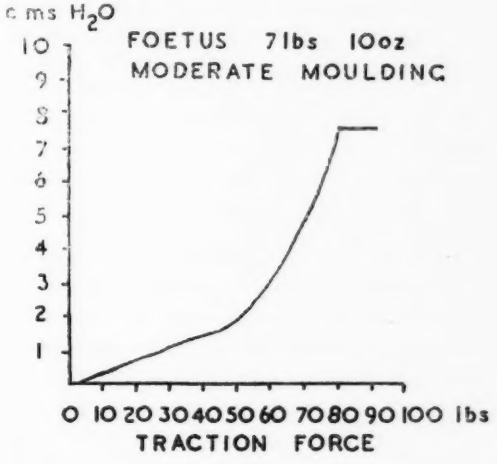

FIG. 4

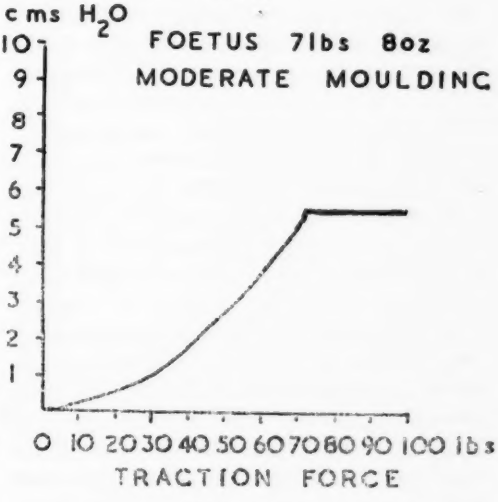

FIG. 5

NOTE—Figs. 3, 4 and 5, graphic representations of rising intracranial pressure in relation to traction force. (See context.)

In 1 case with extreme moulding the manometer became stationary when traction force was only 40 pounds.

In 2 or 3 cases a result could not be got. Sometimes it was difficult to obtain cerebrospinal fluid, but if it were reasonably certain that the needle had entered the canal the introduction of a few c.cm. of water seemed to re-establish the necessary continuity with the cerebral system. On 2 occasions blood-tinged cerebrospinal fluid was forced along the tube into the manometer.

Attempts to introduce the needle into the cisterna magna were not very successful. Owing to the position of the head, the needle fouls the improvised resistance. If introduced into a lateral ventricle the needle is fouled by the traction rods.

It was early noticed that the water level does not rise *pari passu* with the traction-force and that when a force is exerted and maintained the water continues to rise and only after some time is a stationary level reached. There may be one of two causes operating here. In the first place the continued rise of the water level may be due to the fact that the cerebrospinal fluid is escaping from a wider into a narrower canal. In the second place it may be due to the fact that the resistance of the skull is slowly overcome, and that while any particular compression force will produce a certain degree of moulding, this degree is only reached after the force has been applied for some time.

The interpretation of results was not easy and the number of experiments too few to allow any generalization. They do little more than confirm what most experienced operators believe already. When traction is made on the forceps intracranial pressure begins to rise very early and fairly regularly up to a traction force of 50 pounds. From 50 pounds up to 70 pounds the rise of this pressure is more rapid. A force of 70 pounds appears to be, in the foetus weighing from 7 pounds to 8 pounds, a critical level of traction since in most cases it has been impossible to obtain any rise in intracranial pressure when the force has been raised beyond this. The water level remains stationary even when the force has been raised to 100 pounds and the inference is drawn that traction round about 70 pounds compresses the cranial contents to the extent of interfering with the movement of cerebrospinal fluid from the cerebral system to the spinal canal. The earlier signs of severe compression in the extremely moulded head and their delayed appearance in the unmoulded head are exactly what would be expected.

The fact remains, however, that it has not been possible to demonstrate experimentally the validity of the original theory that intracranial tension only begins to rise when compression force has broken through the resistance and moulding of the skull. Intracranial tension begins to rise as soon as traction force is applied, but how far the early rise is significant is not clear. The normal intracranial tension in the adult is only about 10 cm. of water, yet the total rise through the whole range of traction from 10 pounds to 100 pounds in the still-born foetal head rarely reaches this level.

These experimental results are put forward tentatively. Suitable material has rarely been available to the writer, and some of the earlier experiments were ruined by the difficulty of fixing the head against powerful traction. How far the validity of experimental work is affected by absence of the vitality of living structures, post-mortem changes, loss of normal intracranial tension and many other factors must at present remain largely unknown. Had the results obtained been entirely negative or should further work show some different interpretation, there is still good reason to measure traction force. The greater safety

provided for the foetus and maternal tissues by the "cushion" effect of the spring has already been referred to, but, with experience, by correlating the traction force with the other factors effecting delivery, there comes a more exact knowledge of what can be safely done and what can be done only with some danger. The problem of head compression is a big one, but there is no reason to believe that its solution is utterly impossible.

The Practical Problem.

In practice it has been found that the great majority of forceps deliveries can be completed with a force no greater than 50 pounds and if descent of the head does not begin when this traction force has been reached it may be for one of the following reasons:

(1) There is malposition of the head.
(2) There is extension of the head.
(3) There is disproportion between head and pelvis.
(4) There is other obstruction.
(5) There is malposition of the forceps.
(6) There is a large foetus.
(7) The forceps have been applied too early.

Faced with the necessity of using a traction force greater than 50 pounds it becomes incumbent upon the operator to remove the blades and to review the mechanics of the problem which he has set out to solve. The solution does not often lie in the application of more force. In the majority of cases a more expert technique is required and in a minority of cases another method of delivery is indicated. When the traction force has reached about 70 pounds the limit of safety has been reached in the average case.

There may or may not be much variation in the capacity of individual foetuses of the same weight to withstand head compression —material has not been available to work this out—but as we have no method of gauging this capacity it is obvious that if traction force is to be always safe it must be kept at the lower limits. Weight usually runs parallel with maturity, but when the maturity is the same the heavier foetus would seem to withstand relatively greater compression of the head. Some effect of sub-lethal compression of brain tissue is reflected in the difficulty of getting babies, delivered by the forceps, to feed. During the early days of life such infants tend towards pallor or slight cyanosis, are listless, and apparently the excitability of the sucking reflex is reduced. It is notable that these effects are more frequently seen when the traction force has been high relative to the weight. In general the capacity of the foetal head to withstand compression is directly proportionate to the weight of the foetus, but there is no doubt that the severity of maternal laceration is also in direct proportion to the traction force. In primigravidae especially the danger of severe laceration increases progressively as the indicator moves upwards beyond the 50 pounds mark.

The above statements are applicable irrespective of the depth to which the head has descended into the pelvis—whether it be above the brim or on the pelvic floor.

It is instructive to compare the *vis a tergo* with the *vis a fronte*—the natural powers of expulsion with the unnatural force of extraction. The following passage is from DeLee.[7] "The power of the uterine contraction cannot be accurately measured. Schatz, with his tokodynamometer, a rubber bag half filled with water, lying in the uterus, connected with a manometer, found that the uterine contractions during the first stage showed a pressure of from 7 to 10 pounds, and during the 2nd stage, when the force of the abdominal muscles

was added, it was about trebled. Woodbury, Hamilton, and Torpin, with the optical manometer, found the uterine pressure on the foetal head to be 4 to 8 Kg. (8.8–17.6 pounds) and the abdominal muscles increase these expulsive forces to 12 to 21 Kg. (26.4–46.2 pounds). Clinically, the power of the uterine contraction may often be appreciated. It may crush the baby's head or fracture its bones. The physician's hand in the uterus may be squeezed so hard that it becomes insensible and paralysed, but only in pathologic cases. In rare cases tumultuous action of the uterus and abdominal muscles may eject the infant from the vulva with much force. Probably the ordinary amount of force exerted by the uterus and abdomen rarely exceeds 30 pounds."

Reference to the literature quoted by DeLee shows that the force referred to is a total force. The traction force is also a total force, and not only is it usually very much in excess of the natural forces, but it is applied to the head as a direct pull, whereas the natural forces are applied to the trunk and buttocks and reach the head as an indirect push. There are 3 main factors whereby the natural forces expel the foetus in normal labour: they propel the head into the position of greatest mechanical advantage, they adapt the shape of the head by moulding to increase this advantage, and they produce distenson of the soft parts by effecting a slow and intermittent descent of the head. Traction force is often applied with the head unfavourably placed and extraction is completed in minutes as compared with the hours taken by the expulsive forces in most primigravidae. The soft parts are disrupted rather than distentended by traction force. It would seem, therefore, that the forceps operation in all its details is frequently a complete reversal of the physiological process of expulsion, and it may be asked, need it be so? It is usually possible to bring the head into a favourable position or to apply the blades in such a manner that traction will bring the head into this position. The one factor which lends itself to complete control is the traction force, and yet this is the very one which is most apt to get out of hand. What is the need for haste? If the indication for forceps delivery is foetal distress, rapid extraction by powerful traction may only precipitate the very event which the operation was designed to avoid. If the indication is maternal distress, haemorrhage and shock together with the prolonged anaesthesia necessary to effect repair, may only add to the gravity of the mother's condition. Moreover, unless lacerations are completely repaired—and sometimes despite this—there is always puerperal sepsis, and the aftermath of gynaecological troubles to be reckoned with at a later date.

What is to be done if the head does not come down with a pull up to 50 pounds and the requirements for safe forceps delivery satisfied? The natural forces may be simulated so far as possible, the force raised slowly to 50 pounds, maintained there for a brief period, and then lowered. After 2 minutes the same pull is repeated, and in this way a rhythmical traction force developed. If it is considered that more force is necessary then traction force can be raised by 5 pounds at a time and the same rhythmic repetition exercised with each increment. When the pull reaches 70 pounds the foetus may be in danger of losing its life and severe laceration of the mother, if she be a primigravida, is almost inevitable, for whatever doubt there may be as to the capacity of the foetal head to withstand compression—and it must be admitted that it is considerable—there can be no doubt that as the force is raised above 50 pounds the danger of laceration rises with it. In the case of a multipara with a history of 1

or more spontaneous deliveries of full-time infants, failure of the head to descend with a pull up to 50 pounds always suggests that there is some serious obstruction to descent.

It has been found that sometimes, when the force required to effect delivery with the patient in the lithotomy position has seemed to be excessive, the removal of the blades and the resort to the operation in the left lateral position has allowed delivery by a smaller force. The reason for this is not quite clear but the following case is of interest.

The patient was a young primigravida and the foetus estimated to be about 8 pounds. The head had been on the pelvic floor for nearly 2 hours before forceps delivery was attempted and no difficulty was anticipated. It was soon realized, however, that delivery was to be difficult. With the patient in the lithotomy position the traction force was gradually raised to 95 pounds—a force which experience has suggested to be the absolute maximum even when the foetus is a large one. Failing to effect delivery at this level of traction the blades were removed and reapplied with the patient in the left lateral position when delivery was accomplished with a maximal pull of 80 pounds. In the 1st application the blades had been placed over the ears with the occiput directly anterior and examination of the infant showed that the tip of each blade had reached to the angle of the jaw. The 2nd application of the blades had also been over the ears but it was found that the tips of the blades lay further forward, well over the cheeks with the long axis of each blade lying more accurately in the mentovertical diameter. It would seem that the application of the forceps with the patient in the lithotomy position allows the weight of the shafts and handles as they hang free over the perineum to tilt the blades so that when they are locked they grip the head with their long axis lying across the mentovertical diameter, and the direction of traction then lies too far back. This tilting of the blades is also produced by the tendency to press back the handles against the perineum when locking. The more accurate application of the blades in the left lateral position can be easily demonstrated and may account for the greater ease of forceps delivery sometimes observed. In the above case the infant weighed 8 pounds 4 ounces, and cried lustily immediately it was born, but despite a deep episiotomy there was severe vaginal laceration (Figs. 7 and 8).

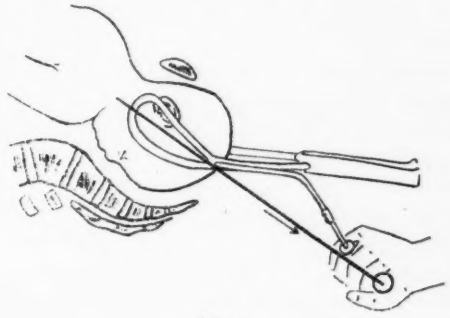

FIG. 7.

Forceps applied in lithotomy position. Tendency is to depress the handles when locking so that long axis of the blades lies obliquely across the mentovertical diameter. Direction of traction then lies too far back.

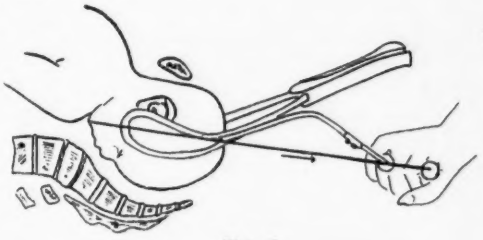

FIG. 8.

The forceps applied in left lateral position. Blades have been accurately placed along the mentovertical diameter. Direction of traction is in the axis of the birth canal.

It is often difficult to estimate the size of the foetus and to correlate it to pelvic capacity. Whether or not traction should be continued beyond 70 pounds will depend on the judgment of the operator. It must be emphasized that the measurement of traction force is not a substitute for judgment and experience, but is merely an adjunct thereto, helping to render judgment more accurate and to narrow down the interpretation of experience to something

more definite than such terms as "stiff" or "difficult" so frequently applied to the forceps operation.

Summary.

1. A method of controlling axis-traction is described.

2. Evidence has been brought forward to suggest that the foetal brain can withstand only a small amount of compression force.

3. When the foetus is of average weight, the head fully flexed, the long diameter lying anteroposteriorly and the forceps accurately applied to the sides of the head, experimental work suggests that dangerous compression force develops with a traction force of about 70 pounds and may be much less if the head is already well moulded by the natural forces.

4. In practice most operations are completed with a force no greater than 50 pounds. The need for greater force suggests the presence of some abnormality.

5. A method of forceps extraction is suggested.

I am indebted to Professor R. W. Johnstone for advice and criticism, also to Dr. John Miller, who designed Instrument No. 2. I wish also to thank Mr. T. C. Riddell, Mr. Spence and the Staff of Messrs. John Hastie and Co. Ltd., for their generous help in the construction of the traction handles. This paper is published with the permission of Dr. Johnstone, Medical Officer of Health, Greenock.

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Correlation of Physical and Emotional Phenomena of Natural Labour

BY

GRANTLY DICK READ, M.D.

THE monograph is presented in reply to requests from doctors and midwives for further information about natural or physiological childbirth. This demand was precipitated by the Report of the Royal College of Obstetricians and Gynaecologists, published just over a year ago, in which references were made to "the excellent results obtained by those who aimed at physiological labour."

The standard textbooks of obstetrics have not yet included this teaching. I have chosen the "Correlation of Physical and Emotional Phenomena of Labour" because I consider it the most important of many aspects of this subject that are worthy of explication. It is not generally recognized that in childbirth there is an "emotional labour" which is as definite and important as its physical counterpart. This must be understood if parturition is to be conducted as a physiological performance.

This investigation has extended over a period of 15–20 years, and observations have been made upon 600–700 cases which I have attended personally, and other records of cases in which the mothers have been conscious at the birth of their children. Anaesthesia, and little or no analgesia, was used in the 2nd stage of labour, although the women were offered it and knew it to be immediately available should they have discomfort which they considered to be unbearable or unjustifiable.

It has been possible, therefore, to observe the phenomena of natural childbirth in the light of modern science, for the act of reproducing a specie is unnatural:

(*a*) If it is an unbearably painful or alarming experience, and

(*b*) If drugs or anaesthetics have masked the significance of either physical or emotional events.

ORIGIN OF THIS RESEARCH.

From certain experiences among the mothers of Whitechapel, Bethnal Green, and later in the rural districts of France and Belgium, and in parts of Asia, I was persuaded that the attitude of a woman towards her confinement had a considerable influence upon the manner in which she bore her child. I had to find an answer to the question—"Is labour easy because a woman is calm, or is she calm because her labour is easy?" and conversely—"Is a woman pained and frightened because her labour is difficult, or is her labour difficult and painful because she is frightened?" From a scrutiny of cases, with these thoughts in my mind, the early hypothesis took shape that—"Fear is in some way the chief pain-producing agent in otherwise normal labour."

In a long series of methodical observations and, so far as possible, controls, this proved to be correct, and is to-day widely accepted as an established theory. The results of its practical application in eliminating pain from natural labour have been favourable, not only in my own practice but in the work of others who have adopted this teaching.

The Pain-Fear-Tension Syndrome of Labour.

Pain is the mental interpretation of harmful stimulus, and fear the intensifier of stimulus-interpretation. The biological purpose of each is protective. The physiological reaction to each is tension.

"A stimulus of fixed magnitude applied to any specific sensory receptor produces a motor response commensurate with the intensity of its interpretation."

In labour, fear produces tension in circular fibres of the uterus by stimulating the sympathetic nerve supply. Tension in these fibres opposes the action of the longitudinal muscle fibres supplied by the pelvic autonomic. Increased tension in the lower uterine segment and cervix causes pain, and pain intensifies fear, and so on, until the exhausting agony of a relatively obstructed labour supervenes!

The motor response to sensory stimuli makes or mars the neuro-muscular harmony of the mechanism. The efferent response is in relation to the intensity of the afferent message, and the polarity of the uterus is sustained by the integrity of afferent impulses and the veracity of their interpretation.

This Pain-Fear-Tension syndrome of labour may be controlled or avoided by correct interpretation of stimulus. The syndrome is most vulnerable to attack at the "point of fear." The causes and conditions of fear in childbirth are numerous. The antidote of fear is confidence, and the establishment of complete faith in the mind of a woman is the most effective method of minimizing pain.

I do not wish to disagree with the advocates of applied anaesthesia, whether it is caudal, inhalation or parenteral, for pain must be prevented or relieved. Every effort to make childbirth a painless function should be carefully considered.

I prefer rather to emphasize emotional influences, and my investigations enable me to postulate as a basis for argument that if fear is eliminated very few physiological labours are so distressing that women will demand relief from pain. If fear predominates a woman should demand anaesthesia in order to escape from pain, for without relief she will most surely suffer.

If the emotional processes of childbirth are understood, they can be preserved, directed and controlled, so that the "threshold of pain" remains constant and the interpretation of sensations faithful.

The phenomena of labour should be taught during late pregnancy and recalled as they present themselves in labour. But the phenomena of labour must be understood in order to be taught. Unless an attendant knows the general trend of the emotional states of a woman in labour, he cannot recognize variations, either within or without the normal. Instruction and the establishment of complete confidence before labour commences is necessary. Physical exercises and relaxation are adjuvants to the fixation of faith as well as to physical performance, for such antenatal classes arouse enthusiasm and interest in childbirth and often afford opportunities for personal relation with the teacher who may and should be with the woman during labour.

A woman who is physically perfect but emotionally uncontrolled will have more difficulty and discomfort than a controlled and confident patient who is without special physical preparation, and who appears to be inadequately equipped for the strain upon her.

Three important precepts should be kept in the mind when considering childbirth as a natural phenomenon:

The first is a maxim of fundamental importance. Physiological labour exhibits certain emotional states which may vary

within normal limits. It must be recognized that if and when emotional manifestations are abnormal, parturition becomes pathological and requires treatment by scientific means as expeditiously as an obstructed labour. It is a serious complication, and one of the major causes of maternal morbidity.

The second is the apothegm that "when a child is born there are 3 labours:

(*a*) of the mother, physical;
(*b*) of the mother, emotional;
(*c*) of the attendant."

The last is frequently distressing! But any one of these 3 components of the event may decide or derange the normality of childbirth.

The third is an axiom: "The art of physiological childbirth is the art of control." This also has 3 specific implications:

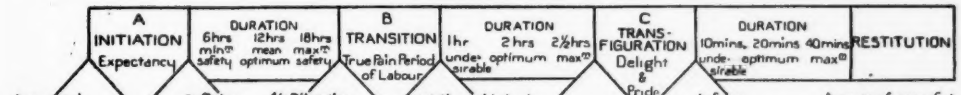
(*a*) The woman's control of herself.
(*b*) The obstetrician's control of the woman.
(*c*) The obstetrician's self-control.

These 3 are largely interdependent, but should (*c*) fail under the provocation of evil anticipation, the course of natural childbirth will immediately be disrupted.

We must therefore apply ourselves to understand the forces of the mind and their influence upon childbirth, and the variations within normal which may occur without inhibition of the mechanism or creation of painful sensations.

For this purpose I have prepared a chart

CORRELATION OF PHYSICAL AND EMOTIONAL PHENOMENA OF NATURAL LABOUR



A1. Commencement
Exilaration and animation.
2. Uterine Cervix dilates
1/5-2/5
Realisation of helplessness, but cheerful.
3. Uterine Cervix dilates
2/5-3/5
Serious demeanour—uneasiness of mind—desire for understanding and companionship.
4. Uterine Cervix dilates
3/5-4/5
Strengthening contractions invite conflict—confidence v. fear—relaxation v. tension.
B5. Uterine Cervix dilates
4/5-full
Test of faith. Acute sensitiveness—horror of loneliness—demand for kindly but firm sympathy and assistance. Beginning of 'True Pain period of Labour'. Demand for relief of unbearable pain justified. Control difficult.
Relaxation during contractions becomes impossible owing to early expulsive efforts occurring.

B6. Expulsive Reflex
Revival of personality and confidence.
7. With Rotation of Head
Onset of amnesia between contractions.
8. Head Mid-cavity
Fundamental primitive self appears. Discretion and discrimination 'low' (variable).
9. Head reaches Pelvic Floor
Impatience and frustration. Careless and willing to remain untidy.
10. Stretching and Thinning of Perineum
Determination and perseverance. Exasperation threatens confidence.
11. Before Crowning
Feeling of mental and physical exhaustion.
12. Stretching of Vulva and Crowning
Discretion and discrimination very weak. Discomfort and anxiety again threaten control.
C13. Birth of Head
Complete awareness. Amnesic state ceases. Mental alertness.
C14. Birth Complete
Entirely concerned with baby. No thought for herself.

C15. Sound of First Cry
Incredulity. All weariness vanishes.
C16. Warmth of Child on her Limbs
Reality.
C17. Sight of Infant
Fascinated wonder. Enchantment.
C18. Her Infant in Her Arms
State of emotional ecstasy which varies both in manifestation and control.
19. Strong and Prolonged Contraction of Uterus.
Reflex and painless stimulus to sympathetic nervous system.
20. Removal of Infant to Cot.
Period of rumination and rest.
21. Rhythmical Contractions
Anticlimax requiring tactfull treatment. Some return of amnesic state may be noted.
22. Placenta in Vagina.
23. Effort of Complete Expulsion
Satisfying sense of accomplishment. Demand for refreshment and her baby to be brought near.

showing the general trend of emotional changes during labour and their relation to the physical progress of parturition.

Such a chart can only show a "general trend," for there is no absolute in human reaction to given circumstance. Variations and degrees of manifestation are as numerable as the experiences, predispositions and associations from which mental processes arise. Such emotional changes as I have recorded are indeed significant for relatively constant occurrence and the absence of gross divergence from the mean.

It is not expected that this purely medical aspect of parturition will appeal to the surgical mind, but in practice it so alters the picture of childbirth that any doubt of the correctness of its theoretical basis is dispelled. By bearing in mind the significance of the pain-fear-tension syndrome, painless natural childbirth can be achieved, and it is upon such cases that these observations upon normal emotional reactions during labour have been made.

(A) *Stage of initiation.*

When a woman has been properly prepared so that her mind and body are in a healthy, fearless condition, there is almost invariably a phase during the last 2 to 3 weeks of pregnancy when she becomes anxious for the birth of her child. It is partly boredom at the limitations which the distended uterus places upon her activities, but an element of impatience and excitement is also present. If this is carefully fostered and she is taught how to recognize the onset of labour, the early signs of the beginning of the 1st stage are heralded with animation and exhilaration. She is delighted that at last her child is coming, and the long months of pregnancy finished. It is of the utmost importance to maintain that sense of fearless expectancy.

The sequence of events from elation is determination, calm, relaxation, conscious control and neuromuscular harmony, with almost complete inhibition of sympathetic nervous system influences. Conversely, if this spirit is suppressed, it may initiate fear and apprehension. Such fear promotes a desire to escape, mental turmoil, protective tension, loss of control, and a disturbed neuromuscular harmony.

If a woman starts labour in a confident, happy and expectant frame of mind, the insidious enemies of control can be repelled by those who are trained to recognize the earliest signs of their intrusion.

As the cervix dilates and the uterine contractions become stronger, the woman becomes quieter. She realizes her helplessness, but remains cheerful. From 2/5th to 3/5th dilatation of the cervix, her animation gives place to a more serious demeanour. If she is practised in the art of physical relaxation during the contractions she does not complain of pain, but a certain uneasiness of mind may be detected. She desires companionship, understanding and sympathetic encouragement. It is extremely important that this phase of labour should be well cared for, for a woman who becomes alarmed is liable to physical discomforts which will make it impossible for the labour to develop its natural course.

When the cervix is 3/5th dilated, the strengthening contractions not only invite conflict in her mind but are frequently coincident with physical tiredness. It is at this time in a 1st stage lasting 10 to 15 hours that an attendant must consider the induction of sleep. According to the type of woman, the experienced observer will be guided in his use of sedatives. It is not for pain that soporifics are advised, for frequently the complaint is not of pain, but of weariness. An hour or 2 of peaceful mental and physical relaxation at this stage is invaluable, not only for the maintenance of control, but also to counteract the real

test which she is likely to undergo between 4/5th and full dilation of the cervix.

(B) *Stage of Transition.*

The conduct of this phase, which I term the transition, is the key to the success of the whole process. When labour is painful it is at this time that women are so frequently allowed to suffer. Physically, they are acutely sensitive, and there is little doubt that abnormal tension of the cervix and even laceration occur in some women however well they have conducted themselves up to this point.

The appearance and behaviour of a woman during this transition from 1st to 2nd stage is so typical that once observed it will not subsequently be mistaken. It is now that the physician should be present, and it is now that the skilled midwife will send for him. A woman needs kindly and firm sympathy; the induction of confidence is often of greater assistance to her than the early induction of anaesthesia. She must be told that this phase is short-lived, that the pain in her back will not increase but will diminish when the expulsive reflex is established. Her sacral region should be rubbed and her courage fortified by the realization of personal care and attention.

With full dilatation her breathing will become interrupted from time to time by a "catch" in the throat which is the initiation of the closure of her air-way. She will expect the irresistible urge to bear down, and although 5 or 6 contractions may occur with this reflex imperfectly established, soon, with adequate instruction, she will hold her breath and gently bear down. From this point the pain in the back (in the absence of any old injury of the back) will disappear. Her sensitiveness decreases, she relaxes between the contractions and wakes to use each expulsive effort with a will. As the head descends, the onset of a dulling of her consciousness between contractions may be observed. I have described this previously as an amnesic state, but recent observations have made me aware of the similarity of the behaviour of a woman in the 2nd stage to that of a man in a state of so-called anoxia. The cause of this mental state, however, is controversial, and a satisfactory explanation has not yet been given for its occurrence.

With the progress of this stage, discretion and discrimination are obviously affected. She will become impatient, careless of her appearance and manner. Remarks are made which are not only incongruous but quite atypical of the woman herself. Such remarks are often either forgotten entirely or only recalled as a fantasy.

When the presenting part reaches the pelvic floor, and when both the woman and her attendant may be called upon to exhibit considerable patience, a feeling of mental and physical exhaustion combined with exasperation at the apparent ineffectiveness of her efforts, will call for encouragement, explanation and confidence.

As she becomes conscious of the stretching of the vulva, the threat of increased discomfort may alarm her. Every woman at this stage should know that anaesthesia or at least analgesia is within her grasp. The urge to escape is more frequently the result of fear than of pain. The sense of impending pain is not infrequently present, but if enquiry is made, many women will explain that it is not what they feel but the fear that the next contraction will be painful that is alarming.

She should, of course, have been warned of the rupturing of the membranes, and the downward thrust and retreat of the head before crowning must be explained. These things frighten or disappoint women if they do not understand them.

(C) *Phase of Transfiguration.*

With the birth of the head there is gratifying relief. If the woman has collaborated, it is possible to prevent injury to the perineum in all but exceptionally inelastic vulvae. With the birth of the shoulders, which usually coincides with the first cry of the baby, she completely recovers her awareness. The amnesic state disappears, and she is alert. It is my custom to rotate the shoulders on delivery so that she may look down and see her baby. She likes to hold or "shake" her baby's hand. There is no thought of discomfort; she usually urges me to deliver the body so that the sex of the child may be known. It is a picture of complete happiness. The questions asked are stereotyped. She is incredulous, and frequently says it is almost impossible to believe. Her physical appearance, mentality and behaviour are completely changed. She becomes, in her happiness, a transfigured woman. She should be handed her baby as soon as the cord is divided.

The influence of this condition of physiological emotional ecstasy upon the uterus is immediate contraction. The 3rd stage of the parturition of a happy mother is rarely longer than 20 minutes, and maternal loss of blood practically negligible. I have noticed that the placentae of girls bearing illegitimate babies are not infrequently retained. This may or may not be the result of some breakdown in the normal emotional influences upon the uterine mechanism.

The actual expulsion of the placenta is a miniature 2nd stage. Not infrequently there is a return of the amnesic state when the uterus contracts firmly, and again a tremenduous sense of effort followed by relief when it is all over.

Throughout labour, the correlation of the physical and emotional phenomena is so consistent that the dependence of one upon the other cannot be overlooked. To be guided only by the mechanical and physical progress of the function is to know but half the story. If the emotional phenomena are neither observed nor understood they are best excluded by hypnotics and anaesthetics. For if they are uncontrolled and allowed to become abnormal, not only is the physical progress of labour impeded, but the woman is caused to suffer. Such suffering is unjustifiable, and must be prevented.

This series of cases has demonstrated that suffering in physiological childbirth can be prevented by understanding and maintaining the controlled rectitude of the emotions, not for their elimination but for their perfecting influence upon the physical phenomena of a physiological function.

Certain benefits result from the knowledge and control of the emotional phenomena of labour.

(1) Fear can be eliminated, and thereby pain-causing factors excluded.

(2) The natural amnesia of the 2nd stage in a controlled woman produces the equivalent of complete anoci-association without the employment of narcotics or anaesthetics. It must be remembered that anoci-association not only excludes fear and pain but also shock and postpartum neurosis. Inhalation anaesthesia hides pain and fear in the cloak of unconsciousness, but does not prevent postpartum shock or the sequelae of nervous and emotional impairment.

(3) Interference is less frequently necessary in a conscious, controlled patient in labour.

In a recent series of normal cases it was observed that low forceps were used in under 3 per cent, episiotomies under 7 per cent, lacerations of perineum or vaginal mucosa needing repair under 10 per cent.

Retained placenta and postpartum haemorrhage (20 ounces or more) rare. Postpartum shock (severe) 2 cases in over 150

associated with excessive haemorrhage and not with nervous exhaustion.

(4) The desirable stage of transformation—which is obliterated by anaesthesia—increases uterine contractions and expedites placental separation and expulsion with little or no maternal loss. The subsequent reproductory life of many women has been influenced by this experience. They want more children, and cannot understand the "never-again" woman. The importance of this result is inestimable.

(5) The uninjured birth canal, with appropriate exercises, rapidly regains its tone. Subinvolution is uncommon. The majority of women, after a natural parturition, find desire more pronounced and coition mutually more satisfactory. Obstetricians must not overlook the domestic and social importance of this relation. To produce a child and impair a woman's ability to be a good marital partner all too frequently ruins a home. Forceps, episiotomies and inadequately repaired perineums have more than obstetric implications.

(6) From natural labours we can learn the significance of the physiological phenomena of parturition. With fuller understanding pain and fear will be eliminated from childbirth. Women will again be willing to have more children and once more build up society upon the solid foundation of family life. From natural childbirth we may discern the solutions of many problems which may well revolutionize our attitude towards and our conduct of labour.

For instance, what is the disposition and nature of the fuel of excitation in the early 1st stage which is consumed in hilarity until muscular activity of strengthening uterine contractions employs it?

Emotional tone is diminished by kinetic reaction, and as the muscle work increases the demeanour of the woman changes.

We must enquire, why should this be so? Has it any relation to the establishment of expulsive contractions, and if so can we retain the balance between fuel and metabolites in order to avoid inertia or excessive violence and the dangers they present?

Shall we not be able to learn more of human reactions to forces beyond human control by the study of labour? Many chemical, electrical and psychological phenomena associated with labour may be investigated, but only in conscious women whose emotional balance is not subjected to fear or pain.

The mysteries of childbirth and the problems of reproduction will not be solved by innovations and interventions. The secrets of this fundamental process of life will gradually dawn upon us as we patiently and humbly strive to discover the genius of God.

Books by the author in which more details of this subject may be found.

"Natural Childbirth," London: Heinemann, 1933.
"Revelation of Childbirth," London: Heinemann, 1942.
"Childbirth without Fear," New York: Harper, 1944.
"Antenatal and Postnatal Care," F. J. Browne. London: Churchill, 1935. Chapter V. "The Influence of the Emotions upon Pregnancy and Parturition."

Intrauterine Foetal Death Due to Rhesus Incompatibility
Its Diagnosis and Management.

BY

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A RELATIVELY common and well-known incident in the practice of obstetrics is the death of the foetus *in utero* during the course of pregnancy. In the majority of instances such death can be explained as being due, for example, to asphyxia, following accidental haemorrhage, placenta praevia, obstructed labour, chronic nephritis and the like, or to foetal abnormalities incompatible with extrauterine existence.

During recent years it has become generally recognized that intrauterine death may occur as a manifestation of haemolytic disease of the newborn or erythroblastosis foetalis, with the delivery of a child with generalized oedema (hydrops foetalis), or with maceration (the 4th variation of the disease as described by Javert,[1] Henderson,[2] Harrison and Meacock[3]).

The iso-immunization theory expounded by Levine, Burnham, Katzin and Vogel[4] in 1941, explains the aetiological connexion between the Rhesus factor and haemolytic disease of the newborn.

The object of this paper is to present data collected from the literature, which may simplify the diagnosis of intrauterine foetal death due to Rhesus incompatibility, and assist in the management of such cases during and after pregnancy, thereby lessening the hazards of incompatible blood transfusions and their attendant dangers.

DIAGNOSIS.

(1) *Previous Obstetrical History.*

A detailed history of previous pregnancies is an important aid in the diagnosis, especially in multiparae who have had 1 or more infants developing jaundice or pallor soon after birth, which children have died without or recovered with a transfusion. One or more unexplained stillbirths, premature labours or neonatal deaths should, in every case, be suspected as being due to haemolytic disease until disproved. It is apparent that the Rhesus factor is responsible in the production of late but not early abortions, according to Schwartz and Levine.[5] (See Cases 1 and 2 described below).

It is a fact that almost all such women bear 1 or more unaffected children, before giving birth to an infant with erythroblastosis, and practically all infants born subsequently are affected with the disease. This fact should not detract, however, from a full maternal serological investigation, particularly in the presence of a history of previous blood transfusion, in primiparae who are delivered of stillborn children.

The following cases illustrate histories suggestive of haemolytic disease of the newborn with intrauterine foetal death.

CASE 1. 7-para; aged 36 years; 6½ months pregnant. Admitted to hospital in 1944 complaining of cessation of foetal movements, which had been present since the 20th week of pregnancy.

Previous obstetrical history. (1) stillbirth, ? cause; (2) living and healthy; (3) died after 16 days with marked jaundice; (4) living and healthy; (5) stillbirth, macerated; (6) died with marked jaundice.

Examination. Size of uterus equivalent to 36 weeks pregnancy. Foetal parts felt with some difficulty. Foetal heart sounds not heard. Blood-pressure and urine normal. Wassermann reaction negative.

Twenty-four hours after admission normal delivery occurred. The infant was stillborn, grossly oedematous, and with signs of early maceration. The placenta was markedly enlarged for the duration of the pregnancy, oedematous, and was more than one-sixth the child's weight (Plate I).

CASE 2. 5-para; aged 34 years; 34 weeks pregnant. Admitted to hospital in 1944 complaining of cessation of foetal movements, a feeling of "heaviness in the lower abdomen," and brownish vaginal discharge.

Previous obstetrical history. 1st marriage.

(1) 1937, premature twins, both died, ? cause; (2) 1938, living and healthy; (3) 1939, living and healthy.

2nd marriage. (4) 1942, died after 24 hours with marked jaundice.

Examination. Uterus over-enlarged for the duration of the amenorrhoea; equivalent to pregnancy at term. Foetal parts not felt. Foetal heart sounds not heard. Brown vaginal discharge, slightly offensive. Blood-pressure and urine normal. Wassermann reaction negative. Normal delivery occurred spontaneously 2 days after admission, following medical induction of labour. The infant was macerated; the placenta pale, unhealthy looking and oedematous, weighed considerably more than one-sixth of the foetus (Plate II).

CASE 3. (Case 1 readmitted in 1945). 8-para; 5 months pregnant, complaining of "not having felt movements." Foetal parts were easily palpable, but the foetal heart sounds were not heard. The height of the fundus of the uterus corresponded with a 32 weeks' pregnancy. X-ray examination revealed a typical frog-like or Buddha-like attitude of the foetus, with a halo around the foetal head. (Javert's sign.)

Spontaneous delivery occurred after artificial rupture of the membranes. The foetus was grossly macerated, and the placenta excessively enlarged for a 5 months' pregnancy (Plate III).

(2) *Abdominal Examination.*

In the majority of cases with hydrops, uterine enlargement is out of all proportion to the duration of the amenorrhoea, due to the combined weight of the foetus and excessively enlarged placenta, and not due to hydramnios (Javert[1]). According to Henderson,[2] in the 4th variation of erythroblastosis foetalis characterized by foetal maceration, hydramnios is common. Difficulty in palpating the foetus is probably due to either excessive liquor or anterior attachment of the large oedematous placenta.

(3) *Serological Investigation.*

(*a*) *Rhesus testing.* It is now generally accepted that the introduction of Rh antigen into an individual in whom it is not normally present, may result in the production of anti-Rh agglutinins. If anti-Rh agglutinins are produced a subsequent pregnancy may terminate unfavourably because the agglutinins transferred to the foetus may cause erythroblastosis, or subsequent introduction of large amounts of blood containing antigen may result in undesirable or even fatal reaction. According to Levine[6] the immunization produced by the Rh factor probably persists for life, serious haemolytic reactions such as oliguria, jaundice and convulsions occurring as long as 22 years after the birth of a jaundiced child. Wiener, Silverman and Aronson[7] report a case of haemolytic reaction 11 years after the birth of the last of 5 Rh positive infants, and Mollison[8, 8a] a case of 16 years interval from the birth of the last child. Butler, Danforth and Scudder[9] report a series of 25 cases with transfusion incompatibility, as manifested by oliguria in 25 cases, jaundice in 10, and convulsions in 8.

Young and Kariher[10] maintain that serious haemolytic reaction may follow transfusion without causing chills, fever or other dramatic symptoms and signs.

Introduction of Rh agglutinins may be accomplished either by the passage through the placental barrier of Rh positive cells from the foetal circulation or by transfusion with Rh positive blood, resulting in immunization of the mother, followed by fatal haemolytic disease of the newborn in the form of foetal hydrops.

The following case illustrates an example of incompatible blood transfusion due to the Rh factor, resulting in foetal hydrops and severe maternal complications.

CASE 4. 2-para; aged 30 years; 36 weeks pregnant. Admitted to hospital because of extreme shortness of breath, palpitation and oedema of the lower extremities, due apparently to anaemia.

Previous obstetrical history. 1940, living and healthy child. No previous abortions.

Examination. The patient was very pale and short of breath; there was oedema of the lower extremities and sacrum. Blood-pressure and urine were normal. Abnormality not found in heart or lungs. Wassermann reaction negative.

Abdomen. Uterus corresponded with the period of amenorrhoea. Vertex presentation, left occipito anterior; foetal heart sounds heard.

In view of the anaemia (haemoglobin 35 per cent) and the nearness of the pregnancy to term, it was decided to give a blood transfusion. One pint of grouped compatible blood was administered slowly. After about 200 c.cm. had been given, severe reaction occurred with a temperature of 101°F., rapid pulse-rate and severe backache. The drip was immediately discontinued.

The foetal heart sounds were not heard soon afterwards, and foetal movements ceased. Labour commenced spontaneously 8 hours later, a stillborn child, with generalized oedema and a pale-pink oedematous placenta, being delivered (Plate IV).

Severe oliguria, with accompanying jaundice supervened in the next 48 hours, only 2 ounces of bile-stained urine being voided. A sodium sulphate intravenous drip transfusion produced rapid diuresis. Blood transfusion with Rh negative blood 3 days later was tolerated without reaction confirming our suspicion of Rhesus incompatibility, after finding a high titre of anti-Rh agglutinins in the maternal serum.

The finding in the mother's blood of typical agglutinins (usually anti-Rh) can be accepted as almost conclusive evidence of affection. On the other hand, failure to find agglutinins, say 20 days after delivery, does not exclude the diagnosis (Stratton and Langley[11]). The mere demonstration that the mother is Rh negative and the infant (or father) Rh positive, can be considered no more than suggestive of affection, in event of failure to find anti-Rh agglutinins in the mother's serum.

The finding of antibody during pregnancy does not prove that the foetus will necessarily suffer from erythroblastosis, firstly because the foetus may be Rh negative (if the father is heterozygous) and therefore not affected, and secondly because on rare occasions it has been shown that an Rh negative mother with Rh antibody during the puerperium may have an Rh positive baby which does not show signs of the disease (Boorman, Dodd and Mollison[12]).

In a series of 24 cases of unexplained intrauterine foetal death well in advance of labour, as evidenced by foetal maceration, Schwartz and Levine[5] found that the incidence of erythroblastosis was somewhere between 16.6 and 29.1 per cent.

In the 4 cases described above, all were Rh negative and revealed a high titre of anti-Rh agglutinins in the maternal serum, thus confirming the diagnosis of intrauterine foetal death due to Rhesus incompatibility.

(*b*) *Wassermann reaction.* The possibility of excessive infarction of the placenta due to syphilis, with intrauterine foetal death and the birth of a macerated infant, is generally accepted as one of the commonest causes of late abortion. A routine Wassermann reaction during the antenatal

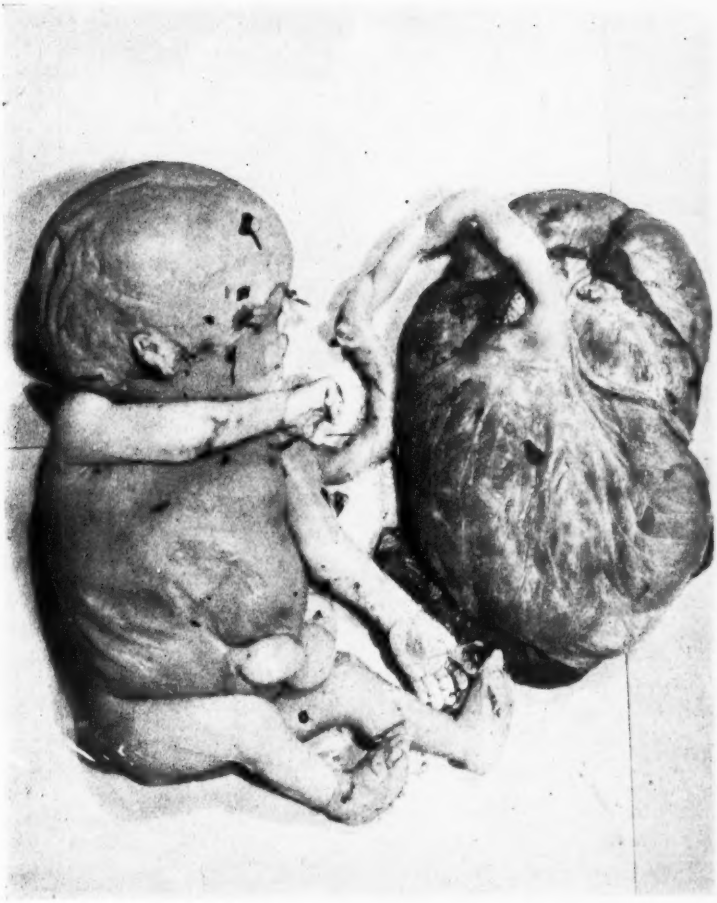

PLATE I.

HAEMOLYTIC DISEASE OF THE NEWBORN.

(26 weeks pregnancy. Hydrops with slight maceration)

L.R.

PLATE II.

HAEMOLYTIC DISEASE OF THE NEWBORN.

(Macerated type. 34 weeks pregnancy)

L.R.

PLATE III.

HAEMOLYTIC DISEASE OF THE NEWBORN.

(20 weeks pregnancy Extreme maceration)

L.R.

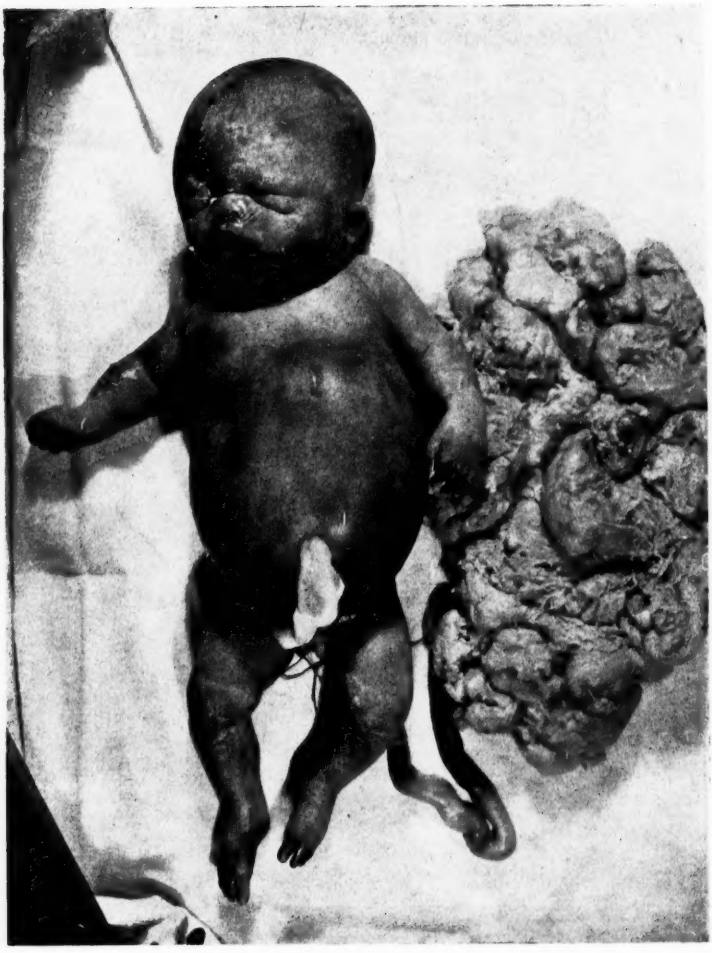

PLATE IV.

HAEMOLYTIC DISEASE OF THE NEWBORN (HYDROPS).

(Following incompatible blood transfusion)

L.R.

period or in the puerperium will usually establish the diagnosis, although a concomitant Rh incompatibility cannot be excluded. The absence of areas of haemopoiesis will however preclude the diagnosis of erythroblastosis.

(4) *X-ray Examination.*

The Buddha-like habitus or frog-like attitude of the foetus *in utero*, due to foetal ascites and enlargement of the liver, is described by Javert[1] as an important diagnostic feature of foetal hydrops, which is further characterized by the presence of a halo around the foetal head due to oedema of the scalp. Overlapping of the foetal skull is a well-known sign of maceration and foetal death.

(5) *Autopsy Findings.*

(a) *Foetus.* In cases of hydrops, the foetus is usually grossly oedematous, the skin easily macerated by the slightest touch. The liver and spleen which are usually enlarged, show some degree of degeneration, pigment deposits and haemopoiesis. Davidsohn[13] describes local haemopoiesis in other organs, including the kidneys and suprarenals. In cases of maceration, described by Henderson, Javert, Harrison and Meacock as a 4th variation of haemolytic disease of the newborn, the foetus shows little or no oedema, marked maceration, and diffuse hepatic cirrhosis and splenomegaly. This type of disease bears a superficial resemblance to congenital syphilis, but close examination of the foetus and placenta renders differentiation easy.

(*b*) *Placenta.* In almost every instance this organ is oedematous and pale pink in colour. The normal weight-ratio of placenta to foetus of 1:6, is decreased. Davidsohn[13] found ratios of 1:1.3, and 1:1.37. The characteristic microscopic changes are fibrosis, oedema and haemopoiesis.

The gross appearance of the foetus and the placenta is in itself not sufficient to establish a diagnosis of erythroblastosis foetalis. Potter[14] believes that certain histological evidence must be present and that all hydropic conditions of stillborn infants should not be accepted as being due to haemolytic disease. She believes that foetal hydrops is not a disease entity, but only a sign common to several different morbid conditions. The possible existence of erythroblastosis was considered in over 100 infants subjected to postmortem examination. Diagnosis of erythroblastosis was established in over 50: in the remainder the condition was believed not to exist. Among those in whom erythroblastosis was absent, 17 had severe oedema characteristically described as foetal hydrops. These infants comprised an entity entirely separate from haemolytic disease. In contrast to erythroblastosis, the spleen and liver were never enlarged and the spleen was often hypoplastic. The maternal histories of these cases showed many differences from those usually found in association with erythroblastosis. Six were primigravidae, a condition which did not occur in erythroblastosis, except for 1 patient who had had numerous previous transfusions. Follow-up of 11 of the 17 mothers revealed that 6 had given birth to 7 normal children, and there were not any subsequent unfruitful pregnancies. This was in contrast to the erythroblastosis group, in which 15 mothers had subsequent pregnancies, 15 of which resulted in the birth of infants with haemolytic disease.

Differential diagnosis. Other conditions producing intrauterine foetal death before term are syphilis, chronic nephritis, essential hypertension, diabetes mellitus, ? excessive calcification of the placenta, abnormal carbohydrate metabolism and other unknown causes.

Management of Intrauterine Foetal Death due to Rhesus Incompatibility.

The main aim would be to obtain a normal delivery, prevent complications in the 3rd stage of labour, particularly postpartum haemorrhage, and prepare for the immediate and energetic treatment of excessive bleeding should it occur. Javert[1] reported an increase in the incidence of postpartum haemorrhage among the hydropic group in the study of 47 cases of erythroblastosis. In the 4 cases reported above, complications in the 3rd stage of labour were conspicuous by their absence. The necessity for Rh negative blood must be stressed, and therefore a suitable donor should be made available, should a blood transfusion be required.

Once the diagnosis has been settled labour can be induced. Stimulation of labour by an oestrin-induction is often successful. Where this procedure fails, routine medical induction will usually succeed. Artificial rupture of the membranes should be performed only as a last resort to bring on labour, because of the increased danger of infection.

In the absence of suitable blood, in cases of emergency, it has been suggested that it would be wiser to administer plasma, until Rh negative blood be made available. It would indeed be a catastrophe if a patient's life were jeopardized or lost, because of incompatible blood (the recent suggestion[15] that all pregnant women be tested for the Rh factor before confinement is wholeheartedly supported).

Finally, before the patient is discharged from hospital, it would be wise to instruct her about her " blood condition " and warn her against confinement " at home."

Question of Further Pregnancies.

The remote chances of further successful pregnancies and the dangers of incompatible blood transfusion, would point against further attempts at conception. The unreliability of contraceptive measures in preventing further pregnancies, may make it advisable to perform surgical sterilization by resection of the Fallopian tubes.

Summary and Conclusions.

1. The diagnosis and management of intrauterine foetal death due to Rhesus incompatibility is discussed.

2. The suggestion of routine Rhesus investigation in all pregnant women is supported, in order to avoid transfusion reactions.

3. The avoidance of further pregnancies, following several unsuccessful pregnancies due to Rhesus incompatibility, is advisable.

My grateful thanks to Dr. F. Stratton, Regional Transfusion Officer, Manchester, for his help in the serological tests for the Rh factor, and his deeply appreciated advice. To Dr. Lois Stent and Dr. G. Crawford I am indebted for their help in the investigation of the cases recorded above, also to Sister Winters who took the clinical photographs. Finally I wish to thank Mr. G. Brown, Medical Superintendent, for his permission to record the cases.

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A Case of Intestinal Obstruction Associated with Complete Procidentia

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ON October 1st, 1945, a woman of 62 was brought by ambulance to the gynaecological clinic. She had been sent for advice about the treatment of her procidentia. The patient had not allowed her private doctor to make a full examination of her condition.

History. Her only complaint was that the womb had been coming down for the previous 10 months, and was now causing discomfort and making it difficult for her to get about. She had had 2 children, the 2nd being born 26 years ago. Deliveries were normal. The menopause occurred at the age of 48, and there had not been any bleeding since. She admitted occasional difficulty with micturition and said that perhaps there had been some recent increase in its frequency. There had not been incontinence. She had not sought treatment for the prolapse and had mentioned it to her doctor only 2 days previously. When asked why she had come to hospital by ambulance, she said that for the last 5 days she had been confined to bed with a "bilious attack" and had not been able to keep down any food or drink. Her bowels, however, had been opened daily without any difficulty until 2 days before admission. She had not had abdominal pain.

On Examination. The patient looked ill; the skin was dry and there was evidence of recent loss of weight. Her tongue was clean and moist. The pulse-rate was 88 and of good volume. The abdomen showed slight general distension and a reducible umbilical hernia. There was no visible peristalsis. Palpation did not reveal any definite evidence of tumour, although there was some fullness in the left iliac fossa. There was shifting dullness in the flanks, and bowel sounds were increased.

At the vulva a complete procidentia could be seen. The cervix was eroded and covered with foul discharge. From a round opening, 1 inch across, in the posterior fornix, about 2 inches from the external os, there extruded a coil of small intestine, some 18 inches long, with its mesentery. It was markedly discoloured and, on the antimesenteric border of the middle of the loop, there was a gangrenous area 3 to 4 inches across. On the left side of the intestine there was another gangrenous organ which was supposed at the time to be the appendix. The prolapsed viscera were covered with drying lymph and had an offensive odour. The site of herniation did not form a tight ring and was not closed by adhesions. Gentle palpation with a finger through this orifice revealed the fundus of an atrophic uterus immediately in front and at the level of the vulva. The legs were grossly oedematous.

Showing resected bowel with a ring pessary placed to indicate the site of the operation in the posterior fornix.

D. & C.

UNIV. OF MICH.

The diagnosis was made of intestinal obstruction due to herniation of ileum through a perforation in the prolapsed pouch of Douglas, and the patient was admitted at once to a surgical ward for laparotomy.

Further examination showed a temperature of 100.2°F., pulse-rate 108, respirations 24, and a blood-pressure of 170/110. Heart and lungs were normal.

Operation (by E. N. C.) Anaesthesia was induced with Pentothal and continued with nitrous oxide, oxygen and ether.

Through a right lower paramedian incision it was found that the last 2 or 3 feet of ileum had been dragged down into the pelvis, with 18 inches of it actually prolapsed through an aperture in the everted pouch of Douglas. The ileum proximal to this was distended and the caecum was dragged down to the pelvic brim, the appendix being in its normal relation to it. The ileum was resected at the level of the pelvic brim and a side-to-side anastomosis performed between the proximal loop of ileum and the transverse colon. A caecostomy was made through an oblique incision over the right iliac fossa, to safeguard the anastomosis.

The patient was then placed in the lithotomy position and the resected loop of bowel withdrawn from the hole in the posterior fornix. The structure which had been taken for the appendix was found to be the left Fallopian tube, and this was ligated at its base and removed. After a drainage tube had been inserted, the opening in the posterior fornix was firmly packed with flavine gauze to prevent further prolapse of abdominal contents.

The accompanying plate shows the resected bowel, with a ring pessary placed to indicate the site of the aperture in the posterior fornix.

Subsequent progress. At the end of operation the patient seemed to be in fairly good condition, but in spite of transfusion and other measures, her condition deteriorated and she died some 24 hours later. An autopsy was not obtained.

Discussion.

It would have been remarkable if this elderly patient had survived a severe operation, bearing some resemblance to an abdominoperineal excision of the rectum, after having been completely obstructed for 2 days.

Excision from below was contemplated, but was rejected because of the inflamed and offensive condition of the everted vagina and cervix. A clean anastomosis would have been extremely difficult to obtain and faecal fistula a very probable result. The immediate postoperative shock would possibly have been less, but a severe cellulitis might have resulted from any enlargement of the hole in the posterior fornix which would have been necessary to bring down sufficient bowel to resect through healthy tissue. The problem of preventing a further prolapse of bowel would have been a grave one, as repair of the infected posterior vaginal wall would have been extremely difficult.

The question arises as to the cause of the perforation. There was not any history of trauma to the prolapsed vaginal wall, nor of the use of a cup and stem pessary. There may have been an injury which the patient never mentioned. The only other presumption is that the complete procidentia had been an old standing one and that constant rubbing, probably associated with lack of cleanliness, had been responsible for ulceration with eventual complete breakdown of posterior vaginal wall and underlying tissue and peritoneum. If the perforation was spontaneous, we believe this case of extrusion of a loop of bowel through the pouch of Douglas to be unique.

Improved Design for a Combined Textbook of Obstetrics and Gynaecology*

BY

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IN his Bradshaw Lecture published in 1931, the late John S. Fairbairn[1] wrote: "Etymologically the term gynaecology should cover both midwifery and the diseases of women, but the title that should belong to the whole has been usurped by a part, largely owing to a separation in practice between the two which occurred during the developmental stages of gynaecology. This drift-apart arose from maternity cases being excluded from the general and segregated in special hospitals in pre-Listerian days, and from advances in gynaecology being so far along purely surgical lines that a type of surgeon-gynaecologist arose, and time was when a real divorce between the two divisions of the subject might have taken place. But recent developments have been in the opposite direction, and a greater realization of the essential unity of midwifery and the diseases of women has been a characteristic feature of recent thought."

The concept of the essential unity of obstetrics and gynaecology has found concrete expression in the combined textbook, but the result has usually been disappointing because the author or editor concerned has failed to present the combined subject simply and in logical sequence and has merely produced one or more omnibus volumes containing a mass of information about both obstetrics and gynaecology. This is regrettable because there can be little doubt that the student would have a more balanced outlook on obstetrics and gynaecology if he were brought up, as it were, on a combined textbook.

The purpose of this communication is to suggest that the avowed object of the combined textbook, namely the integration of obstetrics and gynaecology, can be simply and successfully achieved by arranging the subject matter in the following manner:

SECTION ONE.

Anatomy and Physiology of the Genital Organs.
Anatomy.
Development.
Physiology (brief mention of the function of individual organs).

SECTION TWO.

Anatomy and Physiology of the Female Reproductive Function.
The female sex cycle.
Reproductive endocrinology.
Pregnancy.
Labour.
Puerperium.
Newly born child.
Menopausal climacteric.

SECTION THREE.

Management of the Normal Reproductive Function.
Methods of examination.
Puberty and menstruation.
Sexual intercourse.
The maternity services.
Diagnosis of pregnancy.

* Read at the North of England Obstetrical and Gynaecological Society, Manchester, October 19th, 1945.

Antenatal care.
Labour.
Puerperium and postnatal care.
Newly born child.
Menopausal climacteric.

SECTION FOUR.

Pathology of the Genital Organs.
Investigation of a case.
Principal symptoms.
Malformations.
Mechanical lesions (lacerations, displacements, atresia and stenosis).
Inflammation.
Hypertrophy (including subinvolution) and heterotopia (cervical erosion, endometriosis).
Benign tumours.
Malignant tumours.
Retrogressive lesions.
Gynaecological operations.
Other gynaecological procedures.

SECTION FIVE.

Pathology of the Reproductive Function.
Disorders of the female sex cycle.
Disorders of the sexual function.
Sterility.
Anomalies of implantation of the ovum (ectopic, cornual, angular and cervical pregnancy, placenta praevia).
Abnormalities and diseases of the decidua and ovum.
General diseases associated with pregnancy.
Local diseases associated with pregnancy.
General diseases resulting from pregnancy.
Local diseases resulting from pregnancy.
Abortion and premature labour.
Dystocia (faults in the powers).
Dystocia (faults in the foetus, etc.).
Dystocia (faults in the passages).
Obstructed labour.
Injuries and displacements resulting from labour.
Haemorrhage and shock.
Puerperal complications.
Abnormalities and diseases of the newly born child.
Obstetrical operations.
Maternal, foetal and neonatal mortality and morbidity.
Disorders of the menopausal climacteric.

APPENDIX.

Alimentary and urinary tracts in relation to obstetrics and gynaecology.
Medico-legal problems.
Radiodiagnosis and radiotherapy.
Etc., etc.

It will be observed that normal structure and function are described first, then abnormal structure, comprising the "organic" part of gynaecology, and, finally, abnormal function including "dysfunctional" gynaecology. This arrangement makes it possible for all parts or phases of the reproductive function in health and disease to be dealt with in proper sequence.

REFERENCE.

1. Fairbairn, J. S. *Lancet*, 1931, ii, 999.

CRITICAL REVIEW

The Premature Baby

BY

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BECAUSE of the declining population and the low birth-rate, more attention is being given to the prevention of early loss of life, of which the greatest cause is prematurity.

During the last few years the causes of premature birth have been more thoroughly investigated; in addition, more studies have been made of the causes of mortality in the premature infant and the influence of pregnancy, labour and social status on this mortality.

Definition of prematurity.

The definition recommended by the International Committee at Geneva in 1937 is now generally accepted and any infant weighing 5½ pounds or less at birth is considered a premature baby regardless of the period of gestation.

Importance of prematurity.

If all premature births could be eliminated, the stillbirth-rate could be almost halved[1, 2] and the neonatal death-rate more than halved.[1, 2, 3]

Although the incidence of premature birth in the City of Birmingham during 1944 was only 6.3 per cent, yet 44.2 per cent of the stillbirths and 57.3 per cent of the neonatal deaths occurred in association with these premature births.

The United States Bureau of the Census give prematurity as a single cause of death in 47 per cent of neonatal deaths, while Beck[3] in 1941 reported that 60 per cent of the neonatal deaths occurred in premature babies.

Causes of prematurity.

The common known causes of premature birth are maternal ill-health, multiple pregnancy and foetal deformity but the cause is unknown in a large number of cases.

Maternal ill-health.

Maternal ill-health was reported in 32.5 per cent of premature births by Baird[4] and in 47.9 per cent by Crosse.[2] Toxaemia of pregnancy is the greatest cause of maternal ill-health and occurred in 16.1 per cent and 29.3 per cent respectively of the 2 series of premature births just mentioned. Baird[4] has shown that the association of toxaemia with prematurity is twice as common in the poor as in the well-to-do.

Multiple pregnancy.

This complication was reported as occurring in 12.2 per cent of premature births by Baird[4] and 16.6 per cent by Crosse.[2]

Foetal deformity.

Foetal deformity occurred in association with 3.4 per cent of Baird's[4] cases and 5.9 per cent of Crosse's[2] cases.

Unknown causes.

No known cause could be found for the

onset of premature labour in 32.7 per cent of cases by Sandifer,[5] in 37.7 per cent cases by Crosse[2] and in 51.9 per cent of cases by Baird.[4] More attention is now being given to the effect of social conditions on prematurity, and Baird has recently reported that the incidence of prematurity in Aberdeen is almost twice as high in the Registrar-General's social classes III, IV and V, as in classes I and II. In the former classes over 50 per cent of the prematurity is unexplained, while in the latter very few come within this category.

Experiments, such as those of the People's League of Health,[6] Ebbs, Tisdall and Scott[7] and Utheim-Toverüd[8] have shown that the incidence of prematurity can be reduced by ensuring an adequate diet during pregnancy.

Causes of neonatal mortality in the premature baby.

Recent investigations by Wilcox,[9] Diddle and Plass,[10] McNeil[11] and Crosse[2] have shown that the principal causes of death are prematurity only (including atelectasis), intracranial birth injury, infections and foetal deformity.

Prematurity only.

This cause has been found in percentages varying from 50 per cent[10] to 64 per cent[2] of the deaths in the investigations already mentioned.

This cause of death has been reduced each year since 1938 in the City of Birmingham. During 1938–1941, when the neonatal mortality of premature babies was 40.2 per cent, 62 per cent of these deaths were due to prematurity only, compared with 44 per cent during 1944, when the neonatal deaths of premature babies had been reduced to 24.3 per cent.

Birth injury.

Intracranial birth injury has accounted for percentages varying from 12.4 per cent[2] to 21.3 per cent[9] of the deaths.[2, 9, 10, 11] In Birmingham the percentage has risen from 9 per cent to 16 per cent during the period 1938 to 1944 but owing to the fall in the premature neonatal death-rate there is no great increase in the number of deaths due to this cause.

Infections.

Infections have accounted for percentages varying from 11.4 per cent[2] to 23.1 per cent[11] of the deaths.[2, 9, 10, 11] This cause has accounted for approximately 8 per cent of the deaths in Birmingham each year since 1938, but owing to the decrease in the premature neonatal death-rate this indicates a decrease in the total number of deaths due to this cause.

Foetal deformity.

This complication has been associated with 1.1 per cent[9] to 13 per cent[10] of the deaths in the investigations mentioned.[2, 9, 10, 11] During the years 1938 to 1944 in Birmingham, the percentage of deaths associated with foetal deformity has almost doubled (8 per cent of deaths in 1944), but this increase is more apparent than real, because the premature neonatal mortality has been reduced by two-fifths during this time.

Influence of Pregnancy, Labour and Social Status on the Mortality of the Premature Infant.

Influence of pregnancy.

McNeil[11] has given figures showing that abnormality of pregnancy doubles the combined foetal and neonatal mortality of premature infants.

Bundesen[12] considered inadequate antenatal care a large factor in the cause of death in the premature baby. He found complications of pregnancy in 26.5 per cent

deaths of premature babies under 2 weeks, as compared with 10.9 per cent of full-time infant deaths under the same age.

Influence of labour.

According to McNeil[11] complications of labour increase the combined foetal and neonatal mortality of premature infants by about one-fifth.

Operative procedures.

Other things being equal, the lowest mortality-rates are found after a spontaneous vertex delivery and the mortality rises with breech delivery, mid and high forceps extraction and Caesarean section.[3, 10, 12, 13]

Bundesen[12] showed that skilled operative procedures were beneficial when employed for complications of labour, but that they involved great risk of neonatal death when there were no definite indications for interference. It was pointed out that unnecessary interference was particularly hazardous when complications of pregnancy were present.

Caesarean section. High mortality-rates for premature babies delivered by this method have been given by Ingram,[13] Beck,[3] Diddle and Plass,[10] and these workers consider that Caesarean section, in the absence of serious maternal conditions, is not a child-saving procedure.

Clifford[14] pointed out that while Caesarean section eliminated the factor of trauma during delivery, it substituted the one of asphyxia.

Bundesen[12] gave high mortality-rates from asphyxia in infants delivered by Caesarean section, and recommended avoidance of this mode of delivery unless very definite indications were present.

Breech delivery carries a high mortality-rate from intracranial birth injury owing to the compressibility of the premature head, the fragility of the intracranial blood vessels, and the relatively low concentration of prothrombin in the blood. Asphyxia due to aspiration is also likely to occur.

Multiple pregnancy has a definite influence on the neonatal mortality. Beck[3] stated that the additional risks of multiple pregnancy more than offset the increased degree of maturity which the multiple-born infant enjoys over the single-born infant of the same weight. This was also demonstrated by Crosse[2] (24.3 per cent of multiple-born infants dying before the age of 4 weeks, compared with 9 per cent of single-born infants dying within the same period).

Use of oxytocics. Rapid delivery leads to a high foetal and neonatal mortality.[3, 10]

Bundesen[12] has suggested that posterior pituitary extract should be administered with extreme caution during labour, and only when the indications have been determined as proper by an obstetrician.

Anaesthetics and analgesics. The respiratory centre of the premature baby is poorly developed and easily depressed, therefore anaesthetics and analgesics should be used with great care. According to Bundesen[12] "Physicians should bear in mind the threat to the life of the infant produced by the injudicious use of analgesics, and not permit the mother's demands for painless childbirth to overweigh their good judgment to the degree that they employ drugs to alleviate pain at risk to the infant's life." Lund[15] regards the misuse of anaesthetics as one of the more important causes of asphyxia, and the Royal College of Obstetricians and Gynaecologists[16] has drawn attention to the widespread use of anaesthetics and analgesics by unskilled administrators which has resulted in neonatal deaths and stillbirths.

Influence of social conditions.

According to Baird,[4] not only is the incidence of prematurity greater in the

lower social classes, but the proportion of babies with the smaller birth weights is also greater in these classes. This leads to a greater mortality-rate due to the fact that the mortality increases as the birth weight decreases. Baird also found that the mortality in each weight group was greater in the lower than in the upper social classes; in other words premature babies born to poor mothers had a poor vitality.

Results of Investigations.

As a result of these investigations it has become apparent that the mortality due to prematurity will be reduced only by

1. Improved social conditions.
2. More thorough antenatal care for all expectant mothers.
3. More specialized care during premature labours.
4. More specialized care for premature infants after delivery.

Improvement of social conditions.

More efforts must be made with regard to improving housing, wages, diet and opportunity for rest during pregnancy, and if the best results are to be obtained, these improvements must be combined with better health education.

A long-term policy to improve the social status of the lower classes is to be preferred, but during the interim period much can be done during pregnancy, by attention to rest and diet. The importance of "first class" proteins, vitamins and mineral salts should be stressed.

Antenatal care.

Generally speaking, the chances of survival of the child increase with the period of gestation up to term, so that every effort should be made to carry on each pregnancy to as near term as possible. In the presence of maternal ill-health this can only be done if a sufficient number of antenatal beds are provided for the treatment of the conditions likely to lead to premature labour.

Early diagnosis of complications.

The early diagnosis of conditions later to lead to premature labour is of importance, and every pregnant woman should be medically examined at certain stages. The Royal College of Obstetricians and Gynaecologists[16] has suggested that "midwives should not be regarded as competent to undertake unaided the antenatal care of the expectant mother, but should always work in collaboration with the general practitioner or the obstetrician of the clinic." According to Galdston[17] the desirable medical attendant is one "adequately trained and experienced in obstetrics, and so aware of his limitations that, when emergencies arise which are beyond his competence he will not delay in securing help." The Royal College of Obstetricians and Gynaecologists[16] has stressed the importance of special experience for doctors wishing to take part in their suggested National Maternity Service.

Induction of premature labour.

Induction of premature labour should only be considered in the presence of very definite indications, always remembering that the earlier labour is induced the smaller is the chance of survival for the child. Induction of labour in certain conditions deserve mention:

Toxaemia of pregnancy. Induction presents special difficulties in this condition, because the child may die of prematurity if labour is induced too early, but it may die *in utero* if delivery is delayed; in addition the needs of the mother have to be considered. Expert advice should be sought if induction is considered before the 35th week of pregnancy.

Cardiac conditions. As the mortality of the infant is high before the 35th week,

labour should not be induced before this unless special indications are present. If, however, congestive failure develops, the infant mortality rises considerably.[18] Therefore, if there is any fear of this complication arising, induction of premature labour is indicated for the sake of the child as well as for the mother.

Antepartum haemorrhage. When pregnancy is complicated by slight vaginal haemorrhage, it may be possible to delay diagnostic examination until the child has a reasonable chance of survival. Beck[3] recommends hospitalization and large doses of progesterone, in the hope of arresting the haemorrhage and prolonging the pregnancy. The risks to the mother must, of course, be weighed if placenta praevia is suspected. In the case of central placenta praevia when a considerable loss of blood has occurred, more frequent and larger blood transfusions are recommended before Caesarean section is performed in order to reduce the mortality of the infant.[3]

Multiple pregnancy.

Rest combined with the use of progesterone and vitamin E may help to prolong the pregnancy and thus improve the chances of survival of the infants.[12]

Provision of antenatal beds.

Good antenatal care must be supported by a sufficient number of antenatal beds. The Royal College of Obstetricians and Gynaecologists[16] has suggested that the number provided should not be less than one-third of the lying-in beds. This would seem to be an adequate number if hospital accommodation is provided for 70 per cent of all deliveries, as suggested by the College. If, however, less accommodation is available, a larger proportion of antenatal beds will be required in order to deal with the antenatal complications of cases booked for delivery in their own homes.

Care During Delivery.

The chief dangers for a premature baby during labour are intracranial birth injury and asphyxia.

As the result of the studies of Ingram,[13] Bundesen,[12] Beck,[3] and Diddle and Plass[10] on the influence of labour on the mortality of the premature infant, the following points have emerged with regard to the conduct of a premature labour:

1. A spontaneous vertex delivery should be obtained if possible.
2. Interference should be avoided unless definite indications are present; this is very important if complications of pregnancy have occurred.
3. Breech deliveries should be avoided if possible.
4. Caesarean section should be performed only when definite indications are present. Ideally, it should be performed under a local or spinal anaesthetic and sedatives should not be used prior to operation.
5. Sedatives and anaesthetics which depress the respiratory centre are contra-indicated in a normal premature labour.
6. Posterior pituitary extract and other oxytocics should be used only in exceptional circumstances.
7. The use of vitamin K is recommended.

Care of the Infant in the Labour Room.

The possible dangers immediately after delivery are loss of body heat, infection and difficulty in establishing respiration.

Preservation of body heat and prevention of infection must start from the moment of birth. Loss of heat is reduced by keeping the room warm (80°F.), wrapping the child in a towel and blanket as soon as it is born and transferring it to a warm cot after the umbilical cord has been divided.

To prevent infection, labour must be conducted with all the usual aseptic precautions. Even greater precautions than usual should be taken to exclude persons suffering from infection and to ensure that all attendants wear gowns and masks, and wash their hands before handling the child. The child should be received into a sterile or clean towel.

If there are respiratory difficulties, there is some difference of opinion as to the best position in which to place the child. Provided the airway is clear, breathing is made easier by raising the head, but if much fluid is present, the head should be lowered while clearing the air passages. If intracranial trauma is suspected, the head should not be kept low any longer than necessary. The older mechanical forms of artificial respiration have been replaced by modern insufflation methods. Oxygen or 7 per cent CO_2 in oxygen may be used, but pure CO_2 should be avoided.

Windle has shown the advantages of not tying the umbilical cord until it has ceased to pulsate, and this procedure is advised if the condition of the child warrants the necessary delay.

Indication for hospital care.

If the infant has been born at home, it is necessary to decide whether it can be nursed at home or whether it should be removed to hospital. If the home is unsuitable, the infant should be moved, and even if the home facilities are excellent, removal should be urged if respiratory or feeding difficulties are likely. Infants with these difficulties require a 24-hour nursing service, and except in the case of quadruplets or quintets, the only economic method of obtaining this service is in hospital.

When it is decided to transfer a baby to hospital, this should be done at once; before infection, chilling, or feeding difficulties have occurred. The infant should not be bathed, dressed or fed before removal, but left undisturbed in a warm cot until called for.

Transport.

Arrangements must be made to keep the baby warm during transit. Some authorities use electric incubators,[21, 22] while others use baskets heated with hot water bottles.[2] The former are more suitable for long journeys, but the latter give excellent results for shorter journeys.

Babies should be accompanied by a trained nurse or midwife, and facilities should be available for clearing the air passage (a mucus catheter) and administration of oxygen.

Suitable arrangements must be made for cleaning and refitting baskets and incubators between cases.

Hospital Care.

According to the Ministry of Health Circular[23] sent to all welfare authorities in England, the following provision should be made:

1. Warm wards.
2. Cool wards.
3. Isolation wards.
4. Accommodation for nursing mothers.
5. Kitchen.
6. Milk room.

Crosse[2] has stressed the importance of providing demonstration rooms in which mothers can be taught how to look after their babies before taking them home. Such rooms can also be used for mothers coming from their homes to feed their babies.

If institutional treatment were to be provided for every premature baby, approximately 5 to 6 cots would be required per 1,000 live births assuming that 5 or 6 per cent of the live births are premature

and that 1 cot can accommodate 10 infants per year. However, hospital care should be necessary for only a small proportion of infants over 4½ pounds, and a more practical suggestion would be the provision of 2 to 4 cots per 1·000 live births; a minimum of 2 in areas with good housing conditions, but 4 in areas where housing is poor.

The Ministry of Health recommends 10 premature cots for every 100 maternity beds. This figure would not appear to be adequate unless maternity beds were provided for at least 50 per cent of the births in the area.

Siting of units for premature babies.

These units have been set up in both maternity and children's hospitals. On the whole, an attachment to a maternity hospital seems to be preferable, on the following grounds.

1. Infants born in the Maternity Hospital do not have to be moved far.
2. Breast milk is more readily available.
3. The mother can continue under the care of the midwife and obstetrician.
4. There is less risk of infection.

Medical staff.

Although the position of the paediatrician in the ordinary nurseries of a maternity hospital is still controversial, it is generally recognized that he should be in charge of units for premature babies. This paediatrician should visit the ward at regular intervals, conducting ward rounds and discussing current problems, and be available at other times for consultation. He should be responsible for the plan of care, which should be available in writing for the use of both medical and nursing staff. In addition, there should be a medical officer on call, day and night, who will visit the wards daily, examine infants on admission and before discharge, and answer emergency calls.

Nursing staff.

The Ministry of Health Circular[23] recommends a highly skilled nursing staff on a numerical basis of 1 nurse to 1½ infants, and suggests that a unit of 20 cots requires 6 permanent senior nurses who have had special training with premature infants.

Crosse[2] has indicated the importance of having sufficient senior nurses trained in the care of premature babies to ensure at least 1 of these senior nurses being on duty at all hours of the day and night (allowing for sickness and other relief). In this way only, can the pupils be adequately supervised and continuity of care be obtained.

Economic size of unit.

In order to comply with the recommendations of the Rushcliffe Committee a minimum of 4 nurses is required to ensure constant staffing of any unit however small. These 4 nurses can staff a unit of 6 cots, but will all have to be trained in the care of the premature baby. A unit of 12 cots can be staffed with 4 specially trained nurses and 4 pupils. A unit of under 6 cots is, therefore, not to be recommended. With every cot over 6 (and up to about 14) the cost of staffing is reduced because pupils can be used as additional staff.

Size of wards.

Fifty square feet of floor space should be provided for each cot and the maximal number of cots in an open ward (not cubicled) should be 4 to 6; 4 in the wards for the smaller infants, and 6 in those for the larger infants, these being the maximal numbers of each type that 1 nurse can care for satisfactorily.[2] If possible the cots of the larger and older babies (those having a cough reflex, and a strong cry and therefore more likely to spread infection by droplet) should be separated by partitions. If the smaller infants are put into cubicles, the difficulty of constant observation is a dis-

advantage to be weighed against the rather remote possibility of droplet infection.

Home Care.

Recommendations in the Ministry of Health Circular[23] are: a separate room for the mother and baby; provision of equipment on loan by the local authority; a supply of expressed breast milk when necessary; and the services of a paediatrician and a home help. Midwives and health visitors with special training and experience with premature infants are recommended as suitable persons to give attention to premature infants born at home.

The suggested equipment for loan included a cot, clothing, hot water bottles, an electric pad, a feeding-bottle, a thermometer and a mucus catheter. It is, however, doubtful whether an electric pad should be included, owing to the possibility of dangers (especially that of overheating) in unskilled hands.

The importance of the home helps in a complete maternity and infant health service was stressed by the Royal College of Obstetricians and Gynaecologists in their report on a National Maternity Service.[16]

Training of midwives and health visitors is of paramount importance, and the training should be carried out, if possible, in units run on single lines, with methods which can be used on the district.[2]

Subsequent Care in the Hospital Nursery or at Home.

This resolves itself into maintenance of body heat, maintenance of respiration, prevention of infection, careful feeding and early diagnosis and treatment of complications.

Maintenance of body heat.

Experience has proved that an infant thrives normally if the rectal temperature is stabilized between 96°F. and 98°F.: the small babies tend to stabilize at 96°F. and as they gain in weight the level rises to 98°F. The dangers of attempts to raise the rectal temperature to the supposedly normal level of 99.6°F. have been shown by Blackfan,[24] Sisson and Clifford.[25] A temperature below 96°F. is injurious, leading to inanition and atelectasis.

A room temperature of 65°F. to 70°F. (humidity 65 to 70 per cent saturation), and a cot temperature of 80°F. to 95°F., both temperatures depending on the size and condition of the child, will usually maintain the body temperature at the correct level.

A closed incubator may be used if an oxygen bed is required, but excellent results can be obtained with the more simple open incubator or heated cot. Closed incubators should certainly not be considered essential. "A good nurse is worth a dozen incubators."[26]

Clothing should cover the child completely (with the exception of the face); be of such a simple design that it can be changed without undue handling of the child, be made of non-conducting material in order to conserve body heat and be washable. Cotton is inferior to wool in preventing heat loss, therefore should not be used for permanent clothing. In emergency gangee tissue may be used as a temporary measure, but ordinary cotton-wool should be avoided, as it sticks to the body and gets into the child's mouth and nose. A suitable set of clothing for the smaller infants consists of:

1. A flannel vest, open, but overlapping in front, with tape fastenings over the shoulders.
2. A sleeveless flannel gown, open down the front with plenty of overlap and provided with a hood.
3. A soft napkin.
4. An absorbent bib.

If the infant is active, sleeves are provided, and when a weight of about 4½ pounds is reached, the hood is not required.

The provision of a bib prevents the soiling of the gown when regurgitation of food occurs.

Nursing procedures should be carried out with the minimal of exposure. Infants should be weighed in their clothes or in a blanket. Cleaning and oiling should be reduced to the minimum if the temperature is difficult to maintain.

Maintenance of respiration.

The more premature the infant the less must it be handled, if cyanotic attacks are to be avoided. The child should be placed on one or other side and never flat on its back, because of the danger of regurgitation and aspiration. The smaller infants should be fed, changed, dressed and oiled in the cot with the minimum of disturbance: any necessary handling should take place before, and not after, a feed. If oxygen is required, it may be administered by tent or funnel; the nasal catheter should be avoided because of the danger of injury to the mucus membrane and infection.

Prevention of infection.

Infection is the greatest preventible cause of death in the premature baby, and for this reason is extremely important. The danger of infection in hospital is fully recognized, but the danger in the child's own home must also be realized. In Birmingham during the first 9 months of 1945, 275 premature infants were treated at home (only 5 per cent weighed less than 4 pounds at birth) and 160 were treated in the City of Birmingham Premature Baby Unit (20 per cent less than 4 pounds at birth and 60 per cent admitted from their own homes immediately after birth). Of those treated at home 3.7 per cent are known to have died of infections before reaching the age of 4 weeks. There has not been a death from infection among the 160 cases treated in the City Unit during this period. (Since 1931 the incidence of infection in this Unit has been 1.4 per cent.)

A recent publication of the Medical Research Council[27] has drawn attention to the necessity for good ventilation, cot-spacing and the wearing of masks for the control of droplet-borne infection; and the treatment of floors and blankets and care during cleaning procedures for the control of dust-borne infections. Direct infection is prevented by care in handwashing, laundry and food preparation and by the elimination of communal equipment so far as possible.

The Children's Bureau (United States Department of Labor)[28] set out standards and recommendations for hospital care of new-born infants, full-time and premature. In this valuable publication, stress is laid on the importance of bedside care, and the necessity of avoiding communal baths and changing tables.

In the child's own home, one room must be kept for the mother and baby only; all visitors and other children being rigorously excluded.

Feeding.

In a premature baby the sucking and swallowing reflexes may be poor or even absent; there is an increased liability to regurgitation and inhalation of food; the alimentary tract is immature; and there is a greater need for fluids due to the relatively great body-water-content and the relatively poor renal function.[29]

Underfeeding may lead to lethargy, fever, cyanosis, loss of weight, and dehydration, while overfeeding may cause gastric distension, cyanosis, diarrhoea and vomiting. The latter may lead to loss of weight and dehydration, or to inhalation and asphyxia or pneumonia.

The dangers of overfeeding are being more generally recognized. Tow[26] stated that " the premature infant is not a balloon to be blown up " and that " it is all too often that a zealous attendant will attempt to force

feedings; and as a result fluid will be aspirated and death ensue, either because a pneumonia develops, or because of an atelectasis that follows an obstructed bronchus." Hess and Lundeen[21] stated that "the tendency to overfeed the young premature infant is undoubtedly one of the important factors in the mortality and morbidity found among premature babies during their first 3 to 6 weeks of life."

Stress should be laid upon survival rather than on a rapid gain in weight. Anxiety need not be felt unless the initial loss continues after the end of the 1st week, or is greater than 1½ to 2 ounces per pound, or if the birth weight is not regained by the end of the 3rd week. Crosse[2] obtains the best survival-rates with the following daily quantities of fluid (feed):

3rd or 4th day, 1 ounce per pound birth weight.
7th day, 2 ounces per pound birth weight.
10th day, 2½ ounces per pound birth weight.
14th day, 3 ounces per pound birth weight.
After the 14th day, 3 to 3½ ounces per pound birth weight.

The premature baby requires approximately 40 to 50 calories per pound daily by the end of the 2nd week of life, and after this, 50 to 60 calories. If weak feeds are given at first and the strength is gradually increased, the calories will be automatically increased. It is a wise rule to give the lowest caloric value on which an infant will gain satisfactorily, and a small infant should not be expected to gain more than ½ to ¾ ounce daily, if digestive upsets are to be avoided. This applies particularly to the artificially fed infant.

Breast-milk is generally accepted as being the best food for a premature infant. Some authorities prefer to increase the protein content of breast-milk by adding calcium caseinate, skimmed lactic-acid milk or casein hydrolysate, but convincing evidence of the value of this procedure has not yet been published.

If breast-milk is not available, cow's milk can be used successfully if the protein is modified, and the fat content of the feed is relatively low (1.5 to 2 per cent). Suitable feeds are therefore:

1. Sweetened condensed milk (1 in 16 to 1 in 6).
2. Unsweetened condensed milk with 1 drachm cane sugar to 3 ounces of mixture (1 in 12 to 1 in 5).
3. Full cream dried milk with 1 drachm cane sugar to 2 ounces of mixture (1 in 32 to 1 in 16).
4. Peptonised or lactified cow's milk with 1 drachm cane sugar to 2 ounces of mixture (1 in 4 to 1 in 2).

Full cream dried milk is a milk with a relatively low fat content; whereas half-cream dried milk when diluted so as to reduce the protein to a suitable level, contains too little fat for a healthy premature baby. As a general rule, "humanized" milks contain too much fat. Saline and whey should be administered only for definite indications if salt retention and oedema are to be avoided.[30]

Feeds are given from the breast, by a bottle or Belcroy feeder, by a pipette or by catheter, according to the ability of the child to suck and to swallow. The dangers of passing the catheter through the nose (injury and infection) should be realized, and all catheter feeds given by mouth. Catheter feeding is not without danger, and should be used only by trained personnel for definite indications. It should never be used to save time or trouble.

Vitamins. The vitamin requirements are so great that extra vitamins should be given to all premature babies whether breast fed or artificially fed. The recommended dosage of vitamin D varies from 1,400 to 10,000 I.U. daily,[31, 32, 33] but in actual practice a daily dose of 3,000 I.U. has proved sufficient. Concentrates must be used because of the deficiency in the digestion of

fat. Little is known as regards the requirements of a premature baby for the various factors of the vitamin B complex. Litchfield *et al.*,[34] in 1939, reported an improvement in the rate of gain in weight after the use of vitamin B concentrates. In the City of Birmingham Premature Baby Unit the administration is commenced on the 3rd day of life, and a daily dose of 0.2 mg. B_1 and B_2 with 3.0 mg. of nicotine acid is used.

The premature infant has a special need for vitamin C in order to complete the metabolism of its protein intake and a daily dose of 50 mg. is suggested.[35] The administration can be commenced on the 3rd day of life. A suitable initial dose is 5 mg. of a synthetic preparation and this may be increased daily by 5 mg. until 50 mg. is being given each day. At the age of 4 weeks orange juice may be gradually substituted for part of the dose.

Mineral salts. Extra calcium and phosphorus should be given to premature babies, because of their relatively deficient stores at birth and their relatively greater growth after birth. An insufficient supply of these salts will lead to rickets even in the presence of sufficient vitamin D.[36] A suitable preparation is syrup of calcium lactophosphate, which can be given in a daily dose of 1 minim per pound from the end of the 2nd week of life.

No useful purpose is served if iron is administered before the age of 4 to 6 weeks,[37] but if commenced at this age it accelerates the expected rise in haemoglobin after the initial drop[38] and so prevents the development of late anaemia.

Owing to the low clearance of sodium and chlorides by the premature kidney, great care must be exercised in the use of saline.

Hormones. The use of thyroid extract first suggested by Pritchard[39] in 1934, has proved useful in lethargic babies with low body temperatures and atelectasis, if given in a dosage of grains 1/10 per pound daily (in a divided dose). The administration of oestrogen has proved disappointing.[40, 41]

Complications Occurring in the Premature Baby.

Because of physical defects associated with prematurity certain complications occur more frequently in the premature baby than in the full-time baby, but early diagnosis and treatment improve the prognosis.

The premature baby has profited from all recent advances made in the treatment of neonatal complications; for example, transfusion with suitable blood in haemolytic disease; vitamin K and transfusion in haemorrhagic disease; sulphonamides and and penicillin in infective conditions, and the more scientific administration of salt, water and glucose in cases of dehydration.

Continuity of Treatment.

A close contact should be maintained between the doctors and midwives in the district and the hospitals, on one hand; and the welfare authority on the other, so that the health visitor can take over the care of the infant when the midwife leaves, or when it is discharged from hospital. In some areas[2] the health visitor is also asked to visit the home before the child is discharged from hospital, so as to ensure suitable preparation for the reception of the child.

Co-operation Between all Persons Concerned with Maternal and Infant Health.

The reduction of foetal and neonatal death from prematurity can be achieved only if there is full co-operation between the obstetrician, paediatrician, general practitioner, midwife, health visitor and the various administrative officials of the local welfare authority.

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ROYAL COLLEGE OF OBSTETRICIANS AND GYNAECOLOGISTS

58 QUEEN ANNE STREET, LONDON, W.1.

DECEMBER 1945.

Regulations for the Admission of Members.

Notice is hereby given that the Regulations for Admission of Members have been modified by increasing the amount of special and general training required in the minimum period of three years that must elapse between the candidate's obtaining a registrable medical qualification and his application for admission as a Member of the College. These modifications will apply to all candidates who sit for the Membership examination for the first time in January, 1947, or thereafter, with the proviso that candidates who have served in a medical capacity in His Majesty's Armed Forces during the present National Emergency shall have the option of applying for special permission to take the examination at any time under the provisions of the Regulations dated March 1944.

Details of the new Regulations can be obtained from the Secretary of the College.

Notice is also given that it is the intention of the College, when facilities for increased training are available, to increase the duration of the training for the Membership examination to five years. Before the necessary Regulations are introduced sufficient notice will be given to enable an intending candidate to plan his course of training.

A Meeting of the Council was held in the College House on Saturday, January 28th, 1946, with the President, Mr. Eardley Holland, in the Chair.

The following candidates were elected to the Membership of the College:

Constance Lang Beynon
Ernest William Cornwall Buckell
Walter Calvert
Raymond Gerard Cross
Sadashiv Narayan Gardé
Perla Greeves
Emilie Ellen Guthmann
Werner Paul Hirsch
William Kearney
Arthur Harold Colyear Walker
Margaret Weddell
May Davies Westerman

BOOK REVIEW

"Ophthalmia Neonatorum. The Problem after 30 Years of Statutory Notification and 60 Years of Crede-Prophylaxis." By ARNOLD SORSBY, M.D., F.R.C.S. Research Professor in Ophthalmology, Royal College of Surgeons. London: Hamish Hamilton, Ltd., 1945. 66 pages.

IN this monograph there is presented an exhaustive statistical and clinical review of the subject of ophthalmia neonatorum. The author is peculiarly fitted for this task as practically all children in the County of London, suffering from ophthalmia neonatorum, are admitted to the London County Council hospital of which he is ophthalmic surgeon.

The treatise opens with a short, interesting account of the distribution of the disease throughout the world. No explanation is offered for the fact that it is not universally prevalent. Dealing with statistical data accumulated in this country since the introduction of compulsory notification, he shows the extreme variations in the incidence of the disease in different parts of the United kingdom. This is attributable not so much to true variations in incidence, but rather to marked local differences in the criteria by which notification is made. Notification is not condemned, for its object is not the collection of statistical data, but the procuring of supervision and treatment for a child whose sight may be endangered. For a measure of the gravity of the problem, and of the efficiency of the measures taken to deal with it, figures relating to impairment of vision and of blindness due to ophthalmia neonatorum are more valuable. In the past 20 years there has been a gratifying decline in both, especially in the last few years: for this the introduction of the sulphonamides may well be responsible. The figures for London and Scotland, where the rate of blindness so caused is 0.4 per 100,000 births, are comparable. Then follow, each in turn less favourable, the figures for the Administrative Counties of England, the English County Boroughs and the whole of Wales.

In the clinical section the subject is considered from the standpoint of aetiology, prophylaxis and treatment. Whatever may have obtained in the past, Professor Sorsby points out that the main cause of ophthalmia neonatorum to-day is not gonorrhoea. In his experience the causative factors are: gonococci 25 per cent, staphylococci 35 per cent, other cocci 5 per cent, various bacilli 20 per cent, virus 10 per cent, undetermined 5 per cent. Following Crede's silver nitrate prophylaxis there was a great reduction in the incidence of ophthalmia neonatorum. But this reduction has not been progressive. There is reason to believe that ophthalmia neonatorum is no less frequent to-day than it was 25 and possibly 40 years ago. This, he considers to be due to undue emphasis placed upon gonorrhoea as a cause in the past to the comparative neglect of prophylactic treatment of maternal infections other than gonorrhoea. The recognition of a virus-type of ophthalmia neonatorum and a causative virus-cervicitis would confirm this. So, too, would the suggestion that the chemical component of the Crede prophylaxis is probably not effective against organisms other than the gonococcus. For combating the occurrence of gonococcal ophthalmia neonatorum *routine* tests at antenatal clinics for the detection of maternal gonorrhoea are advocated. The merits of silver nitrate and other chemicals used as prophylactics are considered in some detail.

The section on treatment of the established condition will repay careful study. Sulphonamide therapy is shown clearly to be superior to the classical methods of treatment. While gonococcal cases respond most readily, there would seem to be no particular variety of non-gonococcal case which fails to respond to this treatment. The effi-

cacy of the different sulphonamides is compared. Sulphamezathine is probably the most useful as a routine measure. Sulphanilamide was given up because of unpleasant toxic effects. Oral administration is distinctly superior to local application.

The early experiments in treatment with penicillin are described, leading finally to intensive local treatment with a concentration of 2,500 units per cubic centimetre. Such penicillin treatment has been found to be as superior to sulphonamide therapy as that is to the classical methods.

This most valuable monograph should certainly be read by all who practise obstetrics, or who undertake the care of the newborn. Those who have seen the devastating effects of severe ophthalmia neonatorum appreciate fully the importance of prompt and expert treatment. In this paper we are presented with considered conclusions from the unrivalled experience of an acknowledged expert.

To the obstetrician, Professor Sorsby emphasizes that in the prevention of ophthalmia neonatorum the treatment of maternal leucorrhoea of non-gonoccal origin is as important as that of maternal gonorrhoea.

Two quotations deserve attention:

(*a*) First, to remove, if possible, the disease in the mother during pregnancy; secondly, if that cannot be accomplished, to remove artificially as much of the discharge as possible from the vagina at the time of delivery; and third, to pay, at all events, particular attention to the eyes of the child by washing them immediately after delivery with a liquid calculated to remove the offending matter or to prevent its noxious action." (Benjamin Gibson, *Edin. Med. and Surg. Journ.*, 1807, p. 160, quoted by Sorsby.)

(*b*) " The prevention of ophthalmia neonatorum lies in the first place in the treatment of the expectant mother, and this would as yet seem to be an aspiration rather than the reality. How much of an aspiration and how little of a reality is only too clearly shown by the fact that the majority of births in this country do not have the benefit of medical attendance, while antenatal attention is still the exception rather than the rule." (Sorsby, 1945.)

There is a curious similarity in these utterances; after 138 years a challengingly curious similarity.

ANTHONY W. PURDIE.

REVIEWS OF HOSPITAL REPORTS

MEDICAL AND CLINICAL REPORT OF THE SIMPSON MEMORIAL MATERNITY PAVILION, ROYAL INFIRMARY, EDINBURGH, FOR THE YEAR 1944.

THE report is concerned mainly with 3,875 patients treated in the hospital. There is a brief summary of 794 patients delivered in their own homes. There is also a paediatric section. The maternal report deals with the patients discharged during the year while the paediatric report deals with infants born during the year.

There was a total of 18 maternal deaths—2 unbooked patients died undelivered, of delivered patients 5 booked and 6 unbooked died in the hospital, while 5 patients (4 booked and 1 unbooked) died after transfer to the City Fever Hospital. The deaths in hospital among booked cases all appear to have been unavoidable—3 of mitral stenosis and heart failure (grade III), 1 of tuberculous meningitis, and 1 of acute heart failure with acute pulmonary oedema 2 hours after delivery. Death in unbooked cases in hospital were from eclampsia 2, rupture of the uterus 2, puerperal sepsis 2, acute bronchopneumonia 1, and acute suppurative pyelonephritis 1. Of these 2, and possibly 3 appear to have been unavoidable, while in 4, where death appears to have been unavoidable after admission to hospital, with some or improved antenatal care death might have been avoided. Of those transferred to the City Fever Hospital, 4 died of sepsis (1 after childbirth and 3 after abortion) at intervals varying from 10 days to 3 months following delivery or abortion. It is interesting to note that one postabortal case showed the rare condition of general peritonitis due to an anaerobic streptococcus.

Of 25 patients who had eclampsia 2 (8 per cent), died. Quite a considerable amount of information is given about this condition. But in all 25 cases the treatment is described as ' sedatives.' It would have been more instructive had the sedatives used in each case been named. Caesarean section was the mode of delivery in 2 cases, but the reason for the choice is not given. Pre-eclamptic toxaemia was diagnosed in 267 cases (6.8 per cent) and essential hypertension in 43 cases. The standards for these diagnoses are not given.

Placenta praevia occurred 56 times. There was no maternal death. Of 59 infants (3 twins), 16 failed to survive. Of these 16, 11 were of less than 36 weeks' maturity and so were excluded in calculation of the foetal survival-rate. Hence it is said that of the remaining 48 infants 43, or 89.5 per cent, survived. As 26 of the 59 infants were of under 36 weeks' maturity the only reason for the exclusion of the 11 was that they failed to survive. In this condition the infant's prematurity is due to the placenta's being praevia. It seems desirable, therefore, to include all infants in estimating foetal results except where there is present some congenital abnormality which, in itself, is incompatible with life. Viewed in this light the foetal survival-rate is 73.8 per cent.

Among the cases of multiple pregnancy was 1 (booked) of quadruplets. The mother had hypertension. Unfortunately premature labour occured at 28 weeks. All 4 infants died.

Caesarean section was performed 166 times—5 per cent of all hospital deliveries. There were 3 maternal deaths (1.8 per cent). The foetal mortality was 22 (13 per cent). The main indications, foetal deaths and maternal deaths are tabulated, but not with single case details. In those instances where foetal death was highest the main indications for the Caesarean section were placenta praevia 4, primary (uterine) inertia 4, bad obstetric history 3, severe pre-eclampsia 3.

The incidence of ' failed forceps outside ' seems high. There were 12 cases. In hospital only 2 of these were delivered spontaneously. Of the remainder 8 required forceps delivery, 1 Caesarean

section with hysterectomy, while 1 was delivered by internal version and breech extraction. There was not any maternal death. In 9 the child survived, in 4 stillbirth is said to have occurred (1 set of twins), but there is an error in this table, as the figures do not tally.

In 50 cases of uncomplicated primigravid breech delivery the foetal mortality was 3 (6 per cent).

The paediatric section is tabulated but comprehensive. The neonatal death-rate for all infants was 24 per 1,000 viable births and the stillbirth-rate 44.2 per 1,000 viable births. The cause of death was considered to be known in 71 of the 73 fatal cases and confirmed by postmortem examination in 64 cases. The cause of stillbirth was known in 81 of the 133 cases. It was determined by post-mortem examination in 70 cases and by evident congenital defects in 11. Neonatal deaths, morbidity and stillbirths are analysed in considerable detail.

ANTHONY W. PURDIE.

THE MEDICAL AND CLINICAL REPORT OF THE WOMEN'S HOSPITAL, CROWN STREET, SYDNEY, 1943–44.

THIS report deals with the patients in the public wards of this hospital from July 1st, 1943, to June 30th, 1944. As a wartime economy many detailed tables of cases formerly published are replaced by summaries of results. The complete tables have been drawn up, however, and are available to anyone requiring them.

There were 5,254 admissions: 356 to the gynaecological department, 4,004 to the indoor maternity department, and 894 to the isolation department (Founders' Block). In the hospital 3,342 women were delivered of 3,376 babies, while 40 confinements resulting in the birth of 40 babies took place in the district. Out-patient attendances numbered 30,210 for adults and 947 for infants; of these 6,495 and 407 respectively were new cases.

Single case data of maternal conditions are given in complicated breech, eclampsia, antepartum haemorrhage, prolapsed cord, cardiac disease, multiple pregnancy, Caesarean section, version in labour, destructive operations and severe morbidity. The same is done with neonatal deaths and stillbirths. Other maternal and foetal conditions are shown in condensed tabular form. A detailed summary is given of each maternal death.

This condensation necessarily means that important information is withheld. For example out of 105 cases of uncomplicated breech delivery 33 babies (31.4 per cent) were stillborn or died. It is not stated how many of the patients were primigravidae and multigravidae.

Placenta praevia occurred 32 times. There was no maternal death, but 22 babies (68.7 per cent) died or were stillborn. It is interesting to observe of the 10 babies who survived that the maternal treatment was Caesarean section 3, artificial rupture of the membranes 1, medical induction (drug only presumably) 1, and in 4 rest, conservative or expectant. In other words only those babies survived whose mothers were treated by Caesarean section or artificial rupture of the membranes, or who did not require any treatment at all.

The toxaemic problem is recorded only partially. Albuminuria (without eclampsia) occurred in 149 patients. But there is no mention of hypertension without albuminuria. Yet this is a major consideration in any obstetric department. As some of these patients require to have labour induced, it might be supposed that further information could be deduced from study of the table dealing with induction of labour. But this is not so. Here we find that induction was attempted in 151 cases. The methods used were 'medical,' 'artificial rupture of membranes,' 'medical with artificial rupture of membranes' and 'surgical (with or without medical).' The indications for the inductions are not given. What does 'surgical' mean?

Caesarean section was performed 45 times with 4 (9.9 per cent) maternal deaths. Of 46 children delivered 4 failed to survive. Of these 4 rupture of the uterus was the maternal complication in 2, and failed forceps before admission in 1; in the last the child is considered to have died from cerebral anoxaemia.

Maternal morbidity for the whole obstetric department is 5.6 per cent. This is said to be reckoned on the British Ministry of Health standard. That standard, however, is defined erroneously. This section is confusing probably because of inaccuracies. The total number of cases recorded as morbid is 187, yet the number of cases of local uterine infection with temperature over 101°F. is

given as 198. Septicaemia is diagnosed in 3 cases; in one the diagnosis was proved by autopsy, but the other 2 patients survived and in these it would seem that blood culture was either negative or not done at all.

Excluding those patients admitted direct to the isolation department there were 13 maternal deaths in the obstetric department. Of these 5 occurred among booked cases—2 of sepsis, 1 of pulmonary embolism, 1 of ruptured uterus; in the remaining 1, Caesarean section would appear to have been indicated as she died undelivered following attempted forceps operation and then craniotomy. The remaining 8 deaths occurred among emergency cases. Eclampsia was responsible for 4, pneumonia for 1, paralytic ileus following Caesarean section for 1, post-partum haemorrhage for 1, and pulmonary embolism following 'failed forceps outside' and extraperitoneal Caesarean section for the last.

The Infants' Report deals with the babies born in the hospital. The number of these is not quite clear. It is given as 3,376 (page 7) and 3,386 (pages 31 and 32). Calculations are based on the latter figure. The stillbirth-rate is 34.5 per 1,000 births or 22 per 1,000 births at term if premature and non-viable infants are excluded. Similarly the neonatal death-rate is 29 per 1,000 live births or 9 per 1,000 live births when the same correction is made. The combined stillbirth and neonatal death-rate is 62.9 per 1,000 births: when similarly corrected the figure is given as 37.8 per 1,000 births at term. The term 'non-viable' is not defined. Of 250 premature infants born 69 (27 per cent) died.

It is not stated in the infants' report on which cases of stillbirth and neonatal death the cause attributed was confirmed by postmortem examination. This is to be regretted for some of the causes stated are likely to be quite inaccurate if the diagnosis were made on clinical grounds alone. From the report of the Pathology Department it is found that 61 infant autopsies were performed—that is 28.6 per cent.

There is a busy Isolation Department. Here 894 patients were discharged in the year, excluding 163 patients transferred from the maternity department. This block deals with abortions, obstetric sepsis and gynaecological cases with a septic element. Maternal death (excluding 2 cases included in the obstetric department figures) occurred 10 times—all in abortions. Of these 8 were due to sepsis (only 7 are listed in the table of postabortal sepsis (page 44) and 2 to tetanus.

Numerical analyses follow of the work of the Gynaecological, Pathological, X-ray, and Almoner's Departments. A striking figure is the low incidence of carcinoma of the uterine cervix. There were only 2 cases. This is so small a number that it suggests routine admission of such cases elsewhere. The report does not comment on the figure.

This is an exhaustive report which has been shorn of much information to condense it as a wartime measure.

ANTHONY W. PURDIE.

INDEX TO CURRENT LITERATURE

In this Index an endeavour will be made, so far as conditions permit, to maintain an up-to-date record of all titles bearing on obstetrics and gynaecology and the infant. The classification aims at making immediately available for the reader the titles under the various subject headings. In the majority of instances the title is obtained from the original publication. Where this has been impossible, the title has been obtained from the abstracting journal shown in brackets. Reprints will be welcomed and should be sent to the Editor.

Any inquiries should be addressed to Miss D. F. Atkins, British Postgraduate Medical School, Ducane Road, London, W.12.

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PHYSIOLOGY

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2. "Thermogenic effect of progesterone." M. Barton and B. P. Wiesner. *Lancet*, November 24th, 1945, II, 671–2.

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PREGNANCY

NORMAL

Physiology

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Antenatal examination

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See also Ref. 21.

Abortion

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UNIV. OF MICH.

IN MEMORIAM

GEORGE HAROLD ARTHUR COMYNS BERKELEY

M.A., M.D., M.C. (Cantab.), F.R.C.P., F.R.C.S., F.R.C.O.G., M.M.S.A. (Hon.).

1865—1946

Sir Comyns Berkeley

COMYNS BERKELEY'S services to this Journal as Honorary Editor covered the long period from October 1919 until his death in January 1946; during the last three years James Young was associated with him as Joint-Editor. His services were of inestimable value, and they merit full recognition at the hour of his death.

The Journal was founded in 1902 and financed by a small number of men interested in our subject, drawn from all parts of the United Kingdom, who subscribed a modest sum as working capital by taking shares in the private company established for the purpose. It is not surprising that a loss on publication was recorded every year until, when the first Great War broke out in 1914, the Directors judged it to be necessary to suspend publication at once. The Journal was then heavily in debt to the Publishers, who with faith in its future and with great public spirit agreed to carry the debt without charge to the Company. It was not until the autumn of 1919, 5 years after, that it was thought practicable to make an effort to resume publication. The somewhat thankless task of Editorship having been declined by a number of men was finally offered to Comyns Berkeley as the sort of man most likely to make a success of a lost cause. He accepted it and did not disappoint the expectations of his friends, for it is not too much to say that the present position of the Journal is due to his untiring efforts, more than to the work of any other man.

The first concern of the Editor and the new Board of Directors was to make the reappearance of the Journal as widely and as quickly known as possible and, with this object, money was lavishly spent in distributing free copies of the new first issue to all old subscribers who could be traced, and to a large number of prospective new subscribers. This bold policy reaped an immediate reward, and the new list of subscribers grew steadily year by year, with hardly a set-back until a record number was reached in 1945. The Editor and the Board keenly felt the obligation of repaying the debt to the publishers, but it was not until 1932 that this debit finally disappeared from the Balance Sheet.

Thus was the apparently dead brought to life again, and the major share of credit for this act of resuscitation undoubtedly is due to Berkeley and to his patient and sustained editorial work. It must have been a great satisfaction to Berkeley to see his work eventually come to fruition. His Journal now occupies a prominent position among the medical periodicals

of the world, it circulates all around the globe, and attracts contributors and subscribers not only from all parts of the British Empire, but from many foreign lands as well.

In these early years Berkeley's task was indeed arduous and exacting and, when one remembers the many other literary hostages he had given to fortune at that period, it is clear that only a man of quite uncommon capacity for work could have ever dreamed of undertaking it. But Berkeley was indeed one of the hardest workers I have ever known; he worked because he loved work, and was deeply interested in all that he undertook. He worked not in bursts of high activity but by continuous application, supported by a high degree of conscientiousness. His friends sometimes thought that he devoted time to tasks which were hardly worthy of his attention, such as correcting proofs, and on occasions he has told the present writer that he had spent several hours in correcting MSS. sent by a foreign contributor whose ability to express himself clearly in English fell far short of an English editor's standards. His editorial work was the more exacting because he did not make use of such time-saving devices as the employment of a secretary or the delegation of proof-correcting to a sub-editor. One or two of his personal friends gave him assistance in this latter task, but he always took a large share upon himself. His day-time hours were fully occupied with other work, and accordingly he worked for the Journal far into the night, in solitude. His caligraphy was never clear, and at times was almost undecipherable, even to those who had struggled with it for many years. He learned to use a typewriter, but never became a quick or accurate typist.

One of his most difficult tasks at this period was to obtain original articles for publication, and he wrote numberless holograph letters to his friends and acquaintances begging them to send their work to him for publication. At first these appeals met with only partial success, but members of the Board of Directors came to his assistance, and although some of the issues were late in appearing, none was ever entirely missed.

Outside his editorial work for the Journal, Berkeley undertook many literary tasks, sometimes alone, sometimes in collaboration. Perhaps his best work was done in association with his colleague and friend, Victor Bonney, to which tribute has been paid elsewhere. It is not too much to say that their *Text-Book of Gynaecological Surgery* has attained the status of an English medical classic. Then there is the astonishing enterprise of the *Ten Teachers*, the two volumes of which are now in their seventh edition. Berkeley acted as Editor from their first appearance onward, not only keeping his team of highly individualistic experts together, but maintaining their work in both Midwifery and Gynaecology at a high level of popularity and educational value. Only a man endowed with rare personal qualities could have succeeded in such a task. Taking it all in all, Berkeley's literary output was enormous, and must have taken heavy toll of his physical strength although he appeared always to be working well within his powers. It was not until the last few years of his life that signs of strain appeared,

aggravated undoubtedly by war-time anxieties. Not only was his professional residence badly damaged by enemy action, but the health of his wife, to whom he was entirely devoted, broke down, and thereafter he willingly gave up much of his time to provide companionship for her. His friends saw with anxiety that he was becoming a very tired man, but either he did not realize it, or refused to admit it even to himself. The courage with which he carried on all his engagements throughout the period of the war was a revelation of his character which those who worked with him then will not easily forget.

No account of Berkeley's activities would be complete without reference to the part he took in bringing into existence the College of Obstetricians and Gynaecologists, now the Royal College. He was a prominent member of a group of men from all parts of the Empire who worked together in planning the first outlines of its organization. It speedily became clear that the proposal would receive the adhesion and support of almost every British teacher of these subjects not only at home but in all parts of the Empire. Berkeley was an enthusiastic advocate of the scheme, and on the foundation of the College, in 1929, he became one of the signatories to the Articles of Association, and its first Treasurer, Blair Bell having been elected by his co-signatories as the first President. Unhappily, differences very soon arose upon financial matters between members of the Council which made such a deep impression on his perhaps over-sensitive mind that he felt compelled to resign the office of Treasurer and with it his *ex-officio* seat on the Council. This occurrence was a great grief to Berkeley and to many of his friends, for there is no doubt that in happier circumstances he would have brought to the College the generous and unstinted service which was so characteristic of him.

Always interested in the training, the work and the welfare of Midwives, he became a member of the Central Midwives' Board in 1930, and in 1936 he succeeded Dr. J. S. Fairbairn as its Chairman. He was always an active member of the Board, and he took a prominent part in introducing new regulations for the qualifying examination for the State Registered Midwife. When the second Great War broke out he was busily engaged in forwarding a plan for a qualifying examination for "Assistant Midwives". This work was of necessity abandoned, but Berkeley had not given up hope of returning to it later on, and there is no doubt he would have done so had his life been further prolonged.

In 1934 King George V conferred upon him the honour of Knight Bachelor. This recognition of his outstanding services to the department of medicine to which his strenuous life had been devoted was universally felt to be a well-deserved tribute to his work and to his character. To his innumerable friends it gave real joy and to himself a deep satisfaction which was characteristically frank and unconcealed.

T. WATTS EDEN

GEORGE HAROLD ARTHUR COMYNS BERKELEY, who died on January 27th, was born on October 16th, 1865; the eldest son of George Augustus Berkeley and Sarah Louisa, second daughter of Thomas Moore of The Wergs, Wolverhampton. His father was descended from the Berkeleys of Cotheridge Court, Worcester, an offshoot in 1512 of the Berkeleys of Spetchley, Worcester, and through these two families George Comyns was kin both to Earl Berkeley and Lord Fitzhardinge.

Comyns, the name by which he was most usually known, commemorated the family of his great-grandmother, who was a daughter of John Richard Comyns of Hylands, Essex.

At the age of 13 he went to Marlborough School, and from there to Caius College, Cambridge, where he took the B.A. (Natural Science Tripos) in 1888. He then entered the Medical School of Middlesex Hospital and became M.B., B.Ch., in 1902. Thereafter he was successively house physician to Dr. (afterwards Sir) Richard Douglas Powell, house surgeon to Mr. (afterwards Sir) Henry Morris, and obstetric house surgeon to Dr. William Duncan. He also held house physicianships at the Brompton Hospital for Diseases of the Chest, and the Great Ormond Street Hospital for Sick Children. I, as a young student, remember him as a thin young man with fair hair and rather prominent blue eyes.

His special interest in obstetrics and gynaecology evolved during his term of obstetric house-surgeonship, for he began to hold coaching classes for the "Midder" Examinations. They became very popular, and he used to say he had coached men of every nationality except an Eskimo.

In April 1894 he married Ethel Rose, youngest daughter of Edward King Fordham, D.L., J.P., of Ashwell Bury, Herts, and took a lease of 53 Wimpole Street, the house wherein he died 52 years later.

In 1893 the then medical staff of Chelsea Hospital for Women resigned, pending an investigation into certain allegations made against the institution. As a result of this enquiry in 1895 a new staff was appointed which included Dr. William Duncan and Mr. (as he then was) Bland Sutton. Berkeley was made surgical registrar, and 2 years after he was elected an assistant physician. It is to be remembered that in the nineties very few gynaecologists in this country had undergone a full surgical training: they were physicians on to whom a certain amount of surgical knowledge had been grafted. They were styled Dr., not Mr., counted as members of the medical, not the surgical staff, and at several hospitals they were not permitted to perform abdominal section. William Duncan was, however, F.R.C.S.England, and Berkeley had worked both under him and under Bland Sutton before he came to Chelsea, so he had already been introduced to the high standard of gynaecological surgery for which that hospital speedily became famous. I went to Chelsea Hospital for Women as resident

officer in 1898, and so began an association with Berkeley which lasted for 48 years.

In 1901 an obstetric registrarship was created at Middlesex Hospital, and the election proved a momentous one, for, besides Berkeley, Hubert Roberts from St. Bartholomew's Hospital was a candidate, and he was very strongly backed by a certain group of the medical committee. In those days only two of the honorary staff of the hospital had been trained at Middlesex and the staff was divided into two cliques, one favouring outsiders while the other desired more home-grown products. Berkeley was elected by one vote, and time was to prove how fortunate it was, for his election opened his way to the honorary staff whereon he rendered such outstanding service to the hospital.

In 1905 the retirement of Robert Boxall made a vacancy, and Berkeley became assistant obstetric and gynaecological surgeon, while I, who in 1901 had been placed on the honorary staff of Chelsea Hospital for Women, succeeded him as obstetric registrar and tutor. In 1908 William Duncan retired and Berkeley became the head of his department, while I became second-in-command, and for the next 23 years we stood in that relationship. He retired from active work at Chelsea in 1925, and from Middlesex in 1930, having worked at the former institution for 30 years and at the latter (counting his studentship) for 42 years.

The amount of work he accomplished during his life is so large and various that it can best be described in several categories. Taking Middlesex first, from his student days he played a leading part in the social activities of the hospital. Infantile paralysis as a child debarred him from the more strenuous forms of sport, but he was zealous in promoting them, and for many years took a cricket team down to Ashwell to play against the local eleven. He was foremost at all convivial gatherings and sang a good comic song: *Sipping Cider Through a Straw-haw-haw* was, I remember, his *pièce de résistance*. He was the leading spirit and treasurer of the Middlesex Hospital Club, and, with the late Herbert Charles (for so many years his anaesthetist), he initiated the annual smoking concert and annual dance. When the Middlesex Hospital Lodge was founded he was one of its earliest members, and he remained active in the craft for many years.

His good humour, tact, and sterling judgment made him an ideal committee-man, and throughout the years of his service at Middlesex he took part in every meeting concerned with the welfare and advancement of the hospital. He taught assiduously up to the day of his retirement with a simplicity and common sense which appealed at once to the students' understanding. Nor was this all; many men from many generations of students owe him gratitude for sound advice and ungrudging help at times of doubt or trouble.

As regards his professional work at his major hospital, his tenure of seniority (23 years) gave him time to carry through great improvements in his department. The number of its surgical beds was considerably increased, a special operating theatre built, a handsome maternity depart-

ment and a training school for midwives were added, a flourishing antenatal clinic took shape, the extern midwifery service was reorganized, and a closer liaison between the pathological and biochemical departments was established. He operated two days a week in his own theatre, and the number of operations he performed there must have run into many thousands.

At Chelsea Hospital for Women he played a full part in the surgical work. Our team-work began there and is chiefly notable for our association with Wertheim's operation. The operation was first performed in this country by Cuthbert Lockyer in 1905, and in 1906 I, assisted by Berkeley, attempted it, but found the growth too far advanced. I succeeded, however, twice in 1907, and in 1908 (the third case in our series) Berkeley successfully accomplished it with me as assistant. Thereafter, for many years, with one or the other of us as principal, we performed it together and from time to time published our results. When that collaboration came to an end Berkeley unfortunately failed to keep in sufficient touch with his personal patients, and lost sight of so many of them that he was never able to publish authoritative figures, although he had performed the operation in all between 300 and 400 times.

Besides the two hospitals already named, he was for many years attached to the City of London Maternity Hospital, and there, too, rendered services far beyond his strictly professional work.

Throughout the 1914–18 war he and I were the surgeons of the Middlesex War Hospital, Eastern Command, at Clacton-on-Sea. The building was the handsome Middlesex Hospital Convalescent Home, which was emptied for the purpose and staffed entirely from the hospital in town, though we were under the aegis of military headquarters at Colchester. It was a base hospital, and we received convoys of wounded men direct from France and Flanders, who, as they became convalescent, were distributed to the various Red Cross Hospitals in Essex and Suffolk. Altogether some 10,000 men passed through our hands, and we did a great deal of major surgery during the $4\frac{1}{2}$ years we stayed there. As the work at Middlesex and its medical school and at Chelsea Hospital for Women had to be kept going, we arranged for each of us to spend half the week at Clacton and half in London. The half-week in London, when each had to do the other's work as well as his own, was very strenuous. The position we held was curious in two respects: firstly, though we were under the Army we were not of it; and secondly, we got no pay, and, what at that time was still more important, no ration allowance! Later we summarized our experiences in a book which was published by the Middlesex Hospital.

Berkeley's accomplishment as an examiner was unique, comprising the Universities of Birmingham, Bristol, Cambridge, Leeds, Liverpool, London, St. Andrew's, Sheffield, Manchester, and Wales, the Conjoint Board and Apothecaries' Hall. Quite unjustly he was rather feared by many examinees on account of a certain rough joking manner, but actually, as I know from personal experience, he was both kindhearted and lenient.

He was early concerned with the development of radiotherapy, and became the director of the Metropolitan Asylums Board Radium Clinic, later taken over by the London County Council. He was one of the original members and Vice-Chairman of the National Radium Commission, and he represented this country on the Radiological Sub-Commission of the League of Nations, of which he was trustee and Vice-Chairman, making several official tours around the centres in Europe.

During the later years of his life he was closely associated with the Ministry of Health in the production of the Maternal Mortality Reports of 1930 and 1932.

From his early days the nursing profession was one of his great interests. He was Treasurer of the Royal British Nurses Association for 21 years, and afterwards of the Royal College of Nursing, which he helped to form, and he held the same position to the Cowdray Club for Nurses.

For a long time he was one of the examiners of the Central Midwives Board; later he was on the Board as representative of the Royal College of Physicians, and in 1936 succeeded Fairbairn as its Chairman, a post which he held up to his death.

Though he wrote very few individual papers and rarely spoke at meetings, his literary output was very large. He and I collaborated to produce "A Textbook of Gynaecological Surgery," "The Difficulties and Emergencies of Obstetric Practice," "Gynaecology in General Practice," and (with Douglas Macleod added) "The Abnormal in Obstetrics," the last as late as 1938. The idea of writing the first of these books took shape in 1905, but neither of us could then afford the heavy expenses of a professional artist, so I had to teach myself to draw, a process so slow that the first edition of the book did not appear until 1911. The text was written between 9 p.m. and 2 a.m., and at each sitting we consumed a bottle of old port from Berkeley's well-stocked cellar to keep us awake!

Besides these books, he wrote "A Handbook for Midwives and Obstetric Dressers," "Gynaecology for Nurses," and "Pictorial Midwifery," all of which have gone through a number of editions. For many years he was the editor of the "Ten Teachers' Midwifery" and the "Ten Teachers' Gynaecology," the idea of these combined efforts having originated with him, and he also contributed to several of the encyclopaedias. This Journal owes a great debt to him, for he edited it for 23 years, during which period its reputation, both at home and abroad, steadily grew. Others are more competent to speak of this aspect of his activity than I am.

The foregoing pictures a prodigious life's work. What of the man? Berkeley possessed in exceptional degree a native humour, a geniality, a tolerance and a kindness of heart which procured him a multitude of friends. A *bon-viveur* by nature and inheritance, he was invaluable at any gathering where fun and good-fellowship were called for. He had an intense relish for the pleasant things of life, and revelled in good company, especially when it was intimate and gossipy. He was keen on golf and shooting, and attained fair proficiency at each until an accident to his knee prevented

either. He had travelled in many parts of the world. His domestic life up to the last few years was exceptionally happy, and his house, so perfectly presided over by his wife, was a byword for hospitality. He was an expert in good fare and good wine, and entertained royally both at home and at the Garrick Club, of which he was an old member. Many there be who will remember those dinners and suppers with affectionate regret.

Misfortune beset him at the end. His beloved wife's mind broke down, but he was resolute not to part from her. His house in Wimpole Street was shattered by a bomb, and so was the house in Hampstead to which he removed, and his own health began to fail. The death of his wife was the culminating blow, for he had outlived all his relatives and was quite alone. Nevertheless, with indomitable courage he stuck it out, and continued editing his Journal and presiding over his Board until the end came.

Our calling has lost an outstanding figure and many of us a dear friend, whose life exemplifies what immense possibility there is in unfaltering persistence, and teaches us that time is much more spacious than most of us are apt to think, there being within it, if fully utilized, ample room both for great work and great play.

VICTOR BONNEY